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ABSTRACT

This textbook/workbook for secondary school students is designed to stimulate inventive problem solving of future world problems. It is organized into four units and contains 23 lessons. Unit I defines the nature of the course and provides methods for stating and defining problems, brainstorming, working in groups, and judging ideas. Unit II discusses methods for forecasting the future and determining accelerating trends, and food crisis solutions. Unit III focuses on analogies as a means to problem solving. Unit IV presents a "Future Wheel", which is a method of looking for possible consequences and needs that might result from an event or development. Each lesson lists objectives, contains numerous illustrations, and is activity oriented. Students learn to construct checklists and matrices for problem solving. Activities include finding solutions to school vandalism; controlling forest fires; designing uses for old airplanes, warships, and mattresses; and designing solar and underground housing units and a special windmill to meet the needs of a farm family. The final lessons focus on a class-wide activity, Project Vista, a planned community for which students design housing and sit on committees for the environment, education, work, and health and welfare. (KC)

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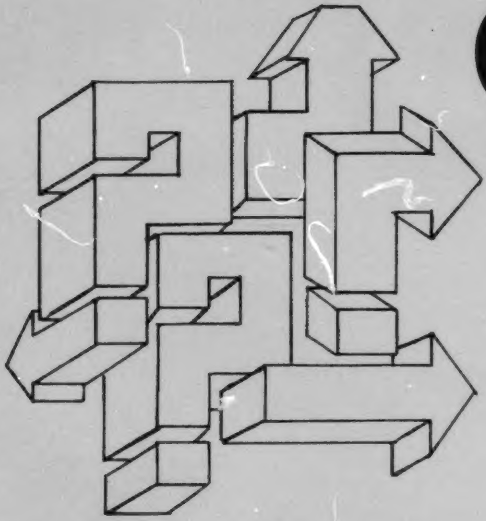
MAKING CHANGES



A FUTURES-ORIENTED COURSE in INVENTIVE PROBLEM SOLVING

Developed by John W. Thomas

SO 013 253

LESSON BOOK

AN ETC PUBLICATION

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MAKING CHANGES

OBJECTIVES – UNIT I

What you should be able to do when you complete each lesson of Unit One:

Lesson 1
- Know the difference between HABIT THINKING and NEW AND DIFFERENT THINKING.

Lesson 2
- Know the difference between a COMPLAINT and a CHALLENGE.
- Know the definition of an OPEN-ENDED PROBLEM.

Lesson 3
- Turn a complaint into a challenge using the HOW? method.
- Write challenge statements using the VERB CHANGE method.
- Write challenge statements using the REVERSAL method.

Lesson 4
- Give a complete definition of a problem by EXPLODING the problem into its parts.
- Use the Explosion method to state a problem in BROAD TERMS.
- Put all the steps together — Challenge Statements, Explosion and Broad Terms.

Lesson 5
- Know the four rules of BRAINSTORMING.
- Be able to use the Brainstorming method alone or in a group.

Lesson 6
- Know the group roles: LEADER, RECORDER, REPORTER, LIAISON.
- Know the rules for working in a group.
- Be able to carry out the roles and rules for group problem solving.

Lesson 7
- Know and be able to use four methods for thinking of ideas: CHECKLIST, PART CHANGING, FORCE FIT and CHECKERBOARD.

Lesson 8
- Know what a CRITERION is and how to use CRITERIA for judging ideas.

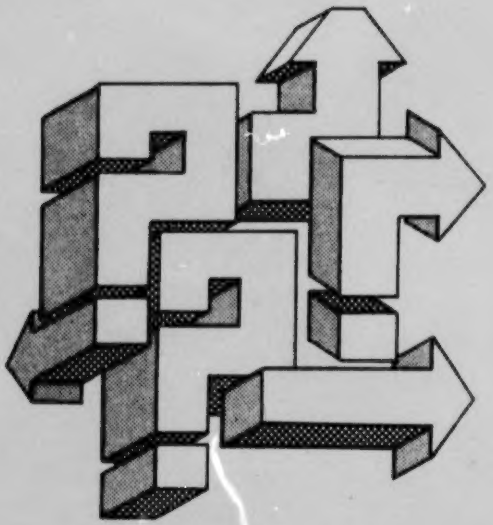
Lesson 9
- Be able to put all the steps and idea methods together to solve a problem.
- Be able to work well with other students in your group.

MAKING CHANGES IS A COURSE ABOUT THINKING

The course will give you many opportunities to use your imagination and to think about things in a new and different way. The course also will teach you some methods that may help you to think of ideas and solve problems.

Making Changes is a course about *making changes*. As the course proceeds, you will be called upon to begin thinking about the future. You will be given projects and problems that will challenge you to think of new ways of doing things for a future that is yours to create. Here are some examples:

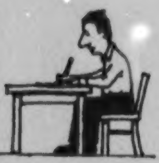
- How will people get around if private cars are banned from large cities?
- What will the high school of 2020 look like?
- How can crime be prevented without the use of guns?
- How and where will you be living in thirty years?

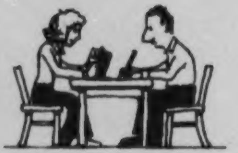


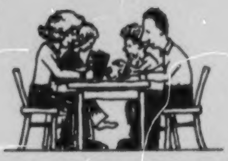
Lesson 1

ACTIVITIES

The diagram below describes some of the things you will be doing during this course.


Working Alone


Working in Pairs


Working in Small Groups

TO SOLVE PROBLEMS BY

THE PROBLEM (TheMess)
Converting Problem "Messes" to Challenges

Exploding a Problem into its Parts

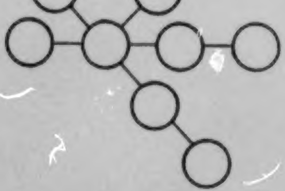
WISH STATEMENTS
Making Wish Statements

Brainstorming Ideas

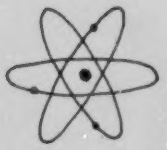
Looking for Analogies

Writing Clash Statements

AND TO EXPLORE ALTERNATIVE FUTURES BY

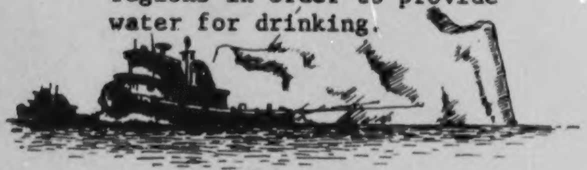

Learning how to make a Future Wheel

Writing Stories set in the Future

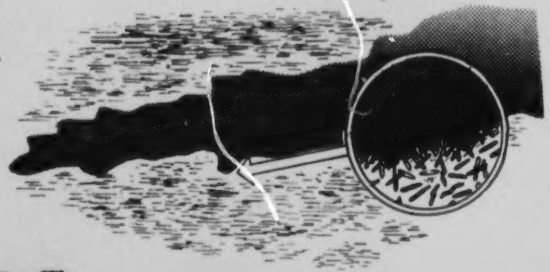

Looking at Major World Problems and New Scientific Developments

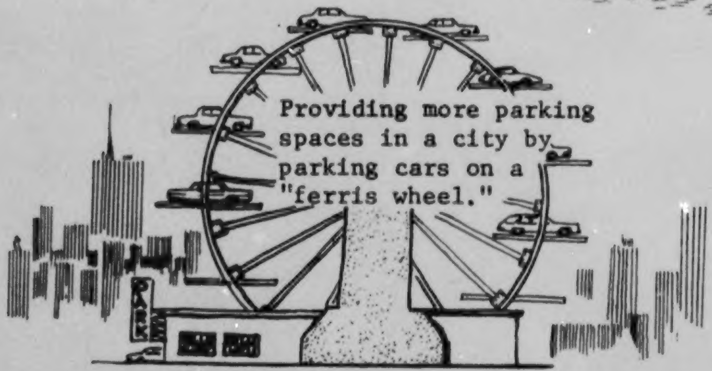
MAKING CHANGES IS ABOUT IDEAS

Pulling icebergs to warm regions in order to provide water for drinking.

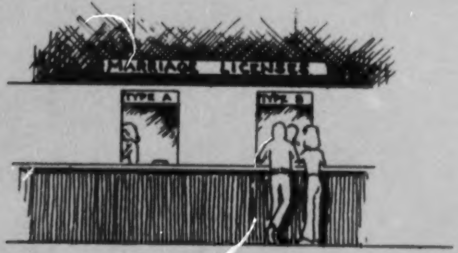


Using bacteria to "eat" oil spills.



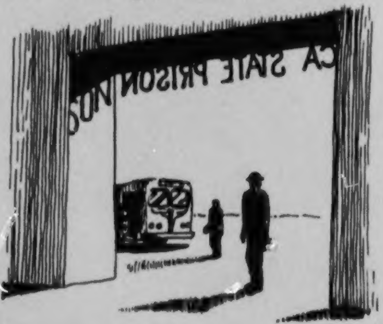


Providing more parking spaces in a city by parking cars on a "ferris wheel."



Having two types of marriage licenses — one for having children like the present license and one for living together that would be renewable every few years.

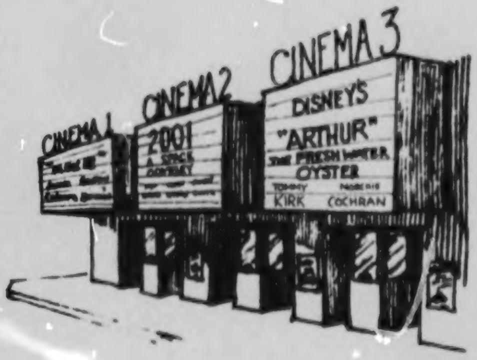
Instead of locking up burglars, muggers and robbers, have them work during the week to pay the victim back and return to prison at night and on weekends.



MAKING CHANGES IS ABOUT USING YOUR IMAGINATION

A. BREAK AWAY FROM *HABIT THINKING.*

For years, movie houses had been trying to attract moviegoers by building larger and larger houses. Theater owners are now breaking away from this way of thinking and are building two, three or more small theaters that show different movies or the same movie at different times.

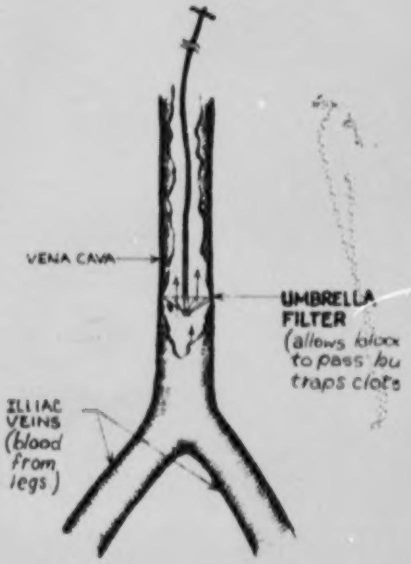

CINEMA 1
CINEMA 2
CINEMA 3
2001
A SPACE ODYSSEY
DISNEY'S
"ARTHUR"
THE FRESH WATER
OYSTER
TOMMY
KIRK
COCHRAN

B. IF AT FIRST YOU DON'T SUCCEED, TRY THE OPPOSITE APPROACH.

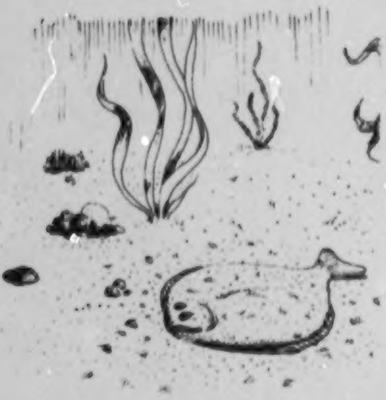
Metal bridges have to be painted every few years to avoid rust. Bridge builders have tried experimenting with long-lasting paints but have not been very successful. Then someone suggested a different idea--why paint at all? Why not let the bridge rust? By coating the metal with a chemical, only the surface of the metal rusts and it rusts an attractive orange color.

C. WILD, UNUSUAL IDEAS CAN SOMETIMES BE BEST.

Blood clots (lumps of blood stuck together) that find their way to the lung can cause serious damage. Attempts to prevent the passage of these clots had been unsuccessful until someone thought of using the principle of the umbrella. A tiny tube could be passed through a vein then twisted so that the end would open up like an umbrella. Blood would pass through but clots would be stopped.


VENA CAVA
UMBRELLA
FILTER
(allows bloo
to pass bu
traps clots
ILLIAC
VEINS
(blood
from
legs)

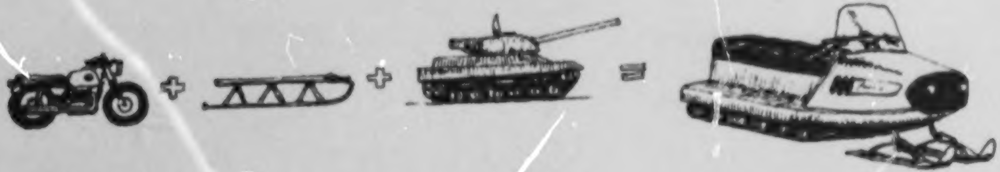
D. LOOK AROUND. HOW DOES *NATURE* SOLVE A PROBLEM LIKE THIS ONE?



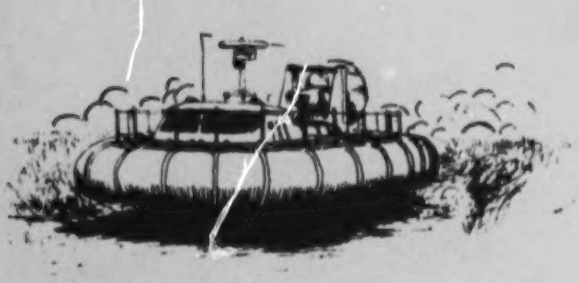
A roof was designed that would reflect the sun's rays in summer (white) and absorb them in winter (black). The idea came from examining how flounders change color to match the color of the bottom of the ocean.

E. TRY TO *FORCE FIT* TWO OR MORE IDEAS TOGETHER.

The snowmobile is a creative idea that combines features of a motorcycle, a sled and a tank.



F. *HITCHHIKE* ON OTHERS' IDEAS.



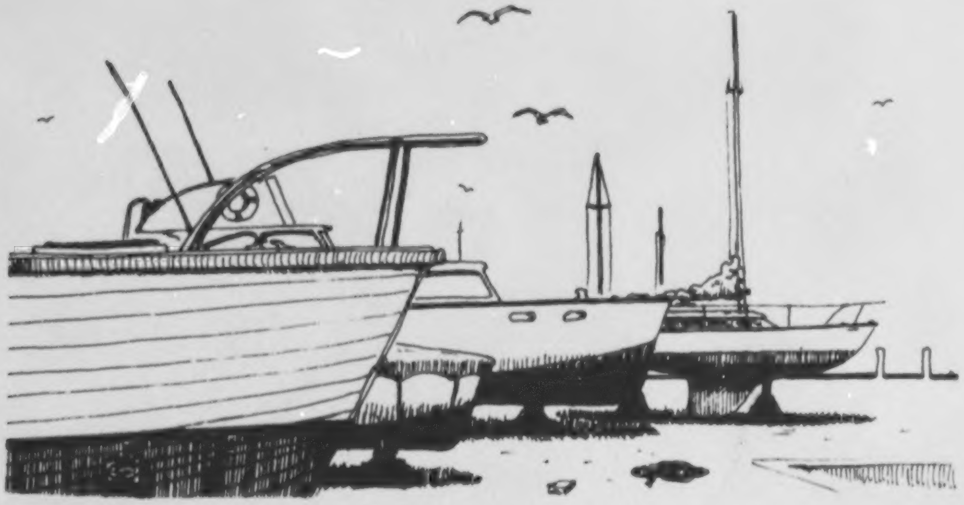
The Hovercraft, a British invention, is a vehicle that suspends itself on a cushion of air and can travel over land or water. Borrowing or "hitchhiking" on this idea, engineers are working on a hover bed for badly burned patients. The patient would lie on a thin film of air.

CHANGING FROM "HABIT THINKING"

Recall the Lost Ball Problem. One solution was to pour water into the cylinder, which is an example of reversing the problem. Instead of thinking of ways to pick the ball out, you reversed your thinking and thought of a way to make the ball come to you.

See if you can use this reversal method for the problem below.

PROTECTING THE BOATS



During the cold winter months, when ice forms on the lake, the boats are moved into cradles on land. This solution is not satisfactory because boats tend to warp in the dry winter air.

DIRECTIONS:

Can you think of another way of protecting the boats during the ice season? USE YOUR NOTEBOOK TO RECORD YOUR IDEAS.

IF YOU NEED A HINT, READ THE BOX BELOW.

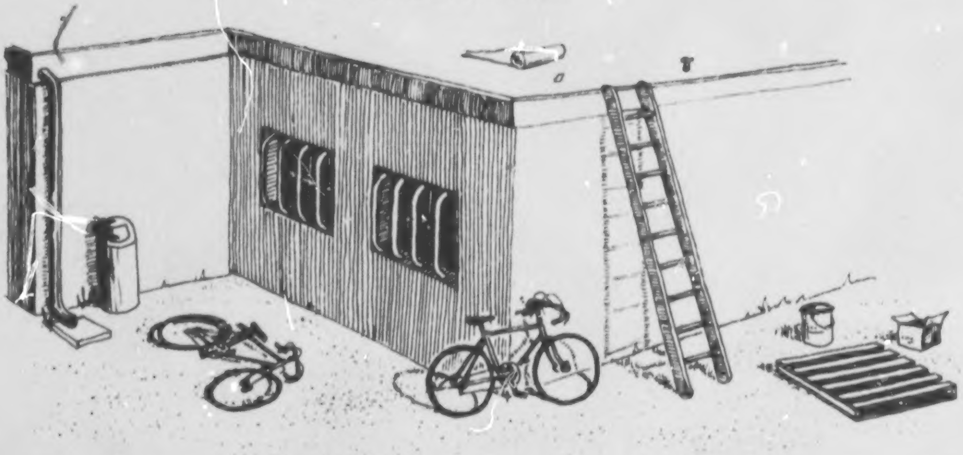
Instead of thinking about keeping the boats away from the ice, how could you keep the ice away from the boats?

TO "NEW AND DIFFERENT" THINKING

Recall what you did to solve the Two Strings Problem. Once you were able to resist "habit thinking" by seeing new uses for the objects in the room, the solution was easy (a cup is not just for drinking but can be a weight as well).

Use this method of looking for new uses in the problem below.

LOCKING THE BIKES



This is a corner of a school building used for parking bikes during the school day. Students would like to have a rack for chaining their bikes, but the principal does not have the money to purchase such a rack.

DIRECTIONS:

Look at the picture carefully. Can you find a way to solve the students' problem? USE YOUR NOTEBOOK TO RECORD YOUR IDEAS.

IF YOU NEED A HINT, READ THE BOX BELOW.

Can you find a new use for the objects in the picture? There are at least four objects that could be used as a bike rack.

Lesson 2

OPEN-ENDED PROBLEMS

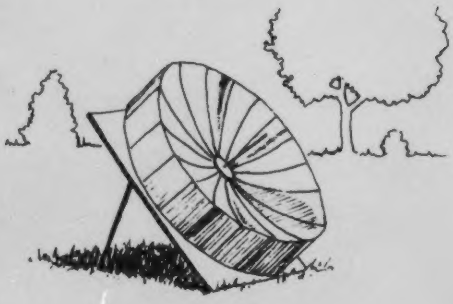
A "close-ended" problem is one that has one and only one answer. An "open-ended" problem has a large number of possible solutions.

A

How and where would you place a solar reflector in order for it to work most efficiently?

B

How might you design a house that would be heated by solar energy?



Problem A is "close-ended." It has only one correct answer.

The reflector must face south (in the northern hemisphere). The angle is calculated by adding 15° to the latitude, e.g., in New York (latitude 41°) the reflector would stand at an angle of 56° to the ground (41 + 15 = 56).

Problem B does not have one and only one correct answer. It is an "open-ended" problem. It is "open" to the imagination. A variety of answers are possible.

Solar cones, glass plates, metal reflectors or mechanical sunflowers can collect the sun's rays in order to heat air, heat water, make steam, charge batteries, even produce hydrogen fuel from the air.

Select the open-ended statement in each pair of problem statements below:

A. 1. How can we figure out how much energy the refrigerator uses in an average month?
   2. How can we reduce the amount of energy used by the refrigerator in an average month?

B. 1. How can we design a roadway that won't collect water when it rains?
   2. How many miles of roadway are there in the United States?

C. 1. How can we keep birds from flying into jet engines on take off and landing?
   2. Where do most of the collisions between jets and birds occur?

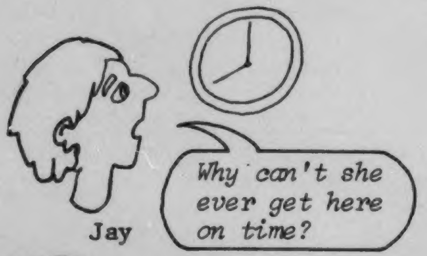
DIRECTIONS:

In your notebook, write down the numbers of the open-ended problems listed above.

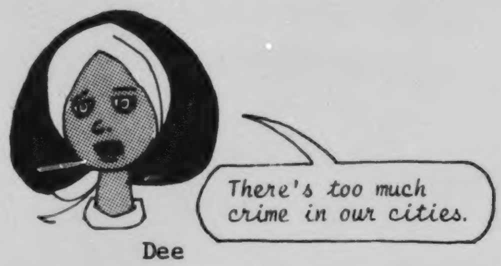
COMPLAINTS vs. CHALLENGES

Making Changes is about problems and how to solve them. You probably already know what a problem is. Most people use the word "problem" to describe a complaint they have.

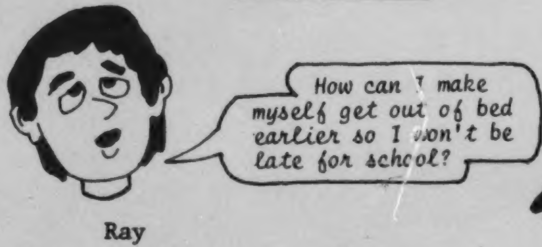
Look at the statements below:


Why can't she ever get here on time?

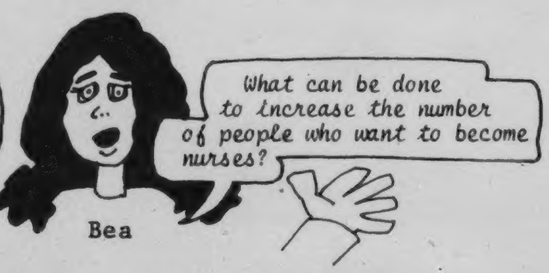
Jay


There's too much crime in our cities.

Dee


How can I make myself get out of bed earlier so I won't be late for school?

Ray


What can be done to increase the number of people who want to become nurses?

Bea

All four people are talking about problems, but with this difference:

Jay and Dee have stated their problems as complaints.

Ray and Bea have stated their problems as challenges.

Complaint: A statement of discontent. A person may complain when something goes wrong. Complaints do not suggest action or ways of looking for solutions.

Challenge: A statement suggesting action. A complaint can be turned into a challenge. Challenges may suggest ways of looking for solutions.

DIRECTIONS:

In your notebook, write a complaint about a real problem you have. Then write a challenge about the same problem.

You may wish to begin your challenge statement with:

"How might I . . . "

"What could I do to . . . "

Lesson 2

DESIGN FOR A SCHOOL BUS

A farming community uses a number of school buses to carry students back and forth to a central school. Some students ride a bus for as long as an hour each morning and afternoon.

One of the bus drivers has complained to the Board of Education that students often become loud and rowdy. The driver says that the disturbances upset his driving, making the journey dangerous. Some students say the long bus ride is extremely boring.

DIRECTIONS:

1. **Write the heading, *DESIGN FOR A SCHOOL BUS,* on the top of a page in your notebook.**
2. **Make a list of all the words and phrases from the paragraphs above that might help you to define this problem. Two words or phrases have been identified for you. find at least *three* others.**
3. **State the problem as a challenge in at least *six* ways:**
   - **two HOW? STATEMENTS**
   - **two VERB CHANGES**
   - **two REVERSALS**
4. ***DESIGN A NEW SCHOOL BUS.* Describe an idea that will solve the problem. Draw and label your idea. You may design a new bus or change the current design.**

STATING PROBLEMS USING HOW?

The easiest way to state a problem as a challenge is to begin your problem statement with the word "HOW."

Complaint	Problem statement using HOW?
My favorite blue jeans are falling apart so my mother wants to throw them away.	How might I stop my mother from throwing my jeans away?

To get the most out of using HOW?, continue to restate the problem in new and different ways.

HOW might I persuade my mother to let me continue to wear my old jeans?

HOW might I save my jeans for some other use?

HOW might I be able to wear my old jeans without making my mother angry?

HOW might I mend my old jeans?

- Each restatement defines the problem in a different way.
- Each restatement suggests different solution ideas.

Practice Problem #1

Complaint	Problem statement using HOW?
The demand for paper bags and wrappings is causing our forests to disappear.	1. HOW might we reduce the demand for paper? 2. ? 3. ?

DIRECTIONS:

Give two additional restatements using HOW?. Be prepared to offer your ideas to the class.

Practice Problem #2

Complaint	Problem statement using HOW?
Hang-gliding is a dangerous sport. A number of people have been seriously injured.	?

DIRECTIONS:

Give two restatements using HOW?. Write them in your notebook.

STATING PROBLEMS USING VERB CHANGE

To use VERB CHANGE, first state your problem using HOW?. Underline the active verb in this statement. Then list as many other verbs as you can think of.

Complaint	Problem statement using HOW?	VERB CHANGE
The sewage treatment plant outside of town is very ugly.	HOW might we beautify the plant?	How might we *paint* the plant?

Notice that in VERB CHANGE, you find the verb (beautify), then substitute another similar verb (paint). It is best to think of as many verbs as you can. Choose those verbs that best define the problem and help you think of a variety of solutions.

Here are other possible verb changes:

camouflage
hide
cover
remodel
remove
spruce-up
rebuild
renovate

Each new verb makes you think about the problem in a new and different way.

Practice Problem #1

Complaint	Problem statement using HOW?	VERB CHANGE
Our streets are dirty.	HOW might we make people keep the streets clean?	How might we *tell* people (to) keep the streets clean?

DIRECTIONS:

Give two additional restatements using VERB CHANGE.

Practice Problem #2

Complaint	Problem statement using HOW?	VERB CHANGE
It's very difficult to catch runaway kids in a big city.	HOW might we catch runaway kids?	?

DIRECTIONS:

Give two additional restatements using VERB CHANGE. Write them in your notebook.

STATING PROBLEMS USING REVERSAL

To use REVERSAL, first state the problem using HOW?. Then turn the problem around.

Complaint	Problem statement using HOW?	REVERSAL
The river is too muddy.	HOW can we get the mud out of the water?	How can we get the water out of the mud?

Notice that in this example, the position of the two underlined nouns ("mud" and "water") is reversed. Reversing the nouns is the easiest way to think of a reversal (although "How can we keep the mud from entering the water" would be a reversal too).

A reversal is a way of turning a problem on its head. Each reversal should help you think of a new way of attacking the problem.

Practice Problem #1

Complaint	Problem statement using HOW?	REVERSAL
People often drive when they've been drinking.	HOW might we stop people from driving cars when they have been drinking?	?

DIRECTIONS:

Give one additional restatement using REVERSAL.

Practice Problem #2

Complaint	Problem statement using HOW?	REVERSAL
People in small farm towns have to travel long distances for medical care.	HOW might the people get to a doctor?	?

DIRECTIONS:

Give one additional restatement using REVERSAL. Write it in your notebook.

USING ALL THREE METHODS

Complaint A: Many office buildings and apartment houses in large cities are so tall that their upper floors cannot be reached by fire department ladder trucks.

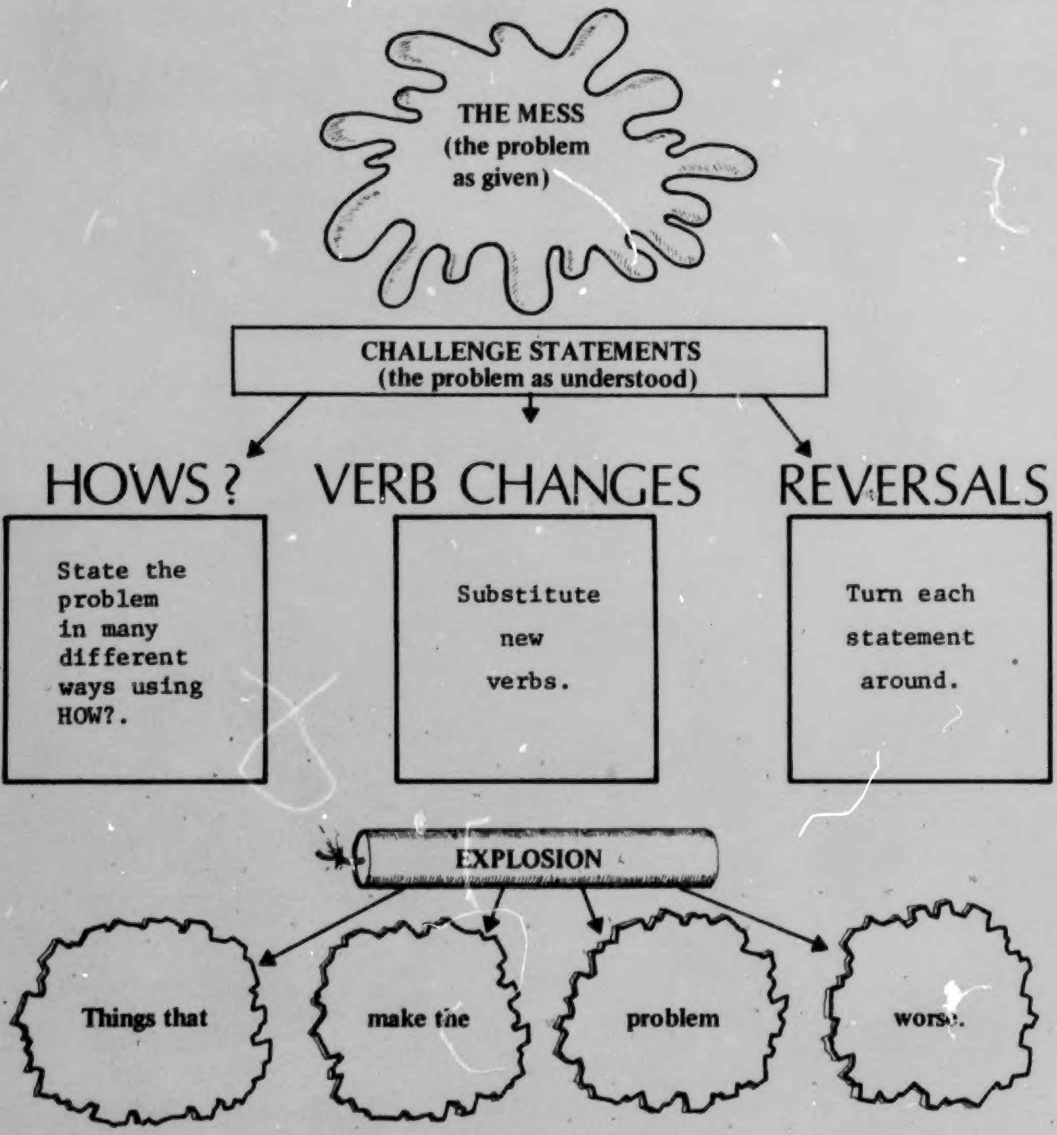
Complaint B: More people should take the time to have a complete checkup (physical examination). Many doctors believe that thousands of lives could be saved each year.

Complaint C: Every few years the river overflows its banks and floods many of the homes in River City.

DIRECTIONS:

1. Choose two of the three complaints.
2. For each complaint, write two How? statements in your notebook.
3. Then choose one of your How? statements and write two verb changes.
4. Finally, write one reversal for each of the two complaints.

Defining Complex Problems



THE MESS
(the problem
as given)

CHALLENGE STATEMENTS
(the problem as understood)

HOWS?

State the problem in many different ways using HOW?.

VERB CHANGES

Substitute new verbs.

REVERSALS

Turn each statement around.

EXPLOSION

Things that make the problem worse.

STATING THE REAL PROBLEM IN BROAD TERMS

- stating the problem in the most general way
- stating the real problem, not just part of the problem
- stating the problem in order to include all possible approaches

Lesson 4

BROAD TERMS

BROAD TERMS means using the widest definition, the most general words. A problem is stated broadly in order to include all possible ideas for solving the problem.

Read this problem:

Complaint:	A number of young children have been hurt playing midget football. Something has to be done.
Problem Statement:	How can we make stronger helmets?

Can you see that this problem statement is very narrow? You would be excluding the ideas for changing the rules of the game, for changing other equipment, and for changing the playing field.

A broader statement would be:

"How can we make midget football a safer game?"

Here's another example:

Complaint:	Several young school children have had close calls with cars while crossing or walking along Green Street. The traffic is heavy and many cars go quite fast.
① Narrow Statement:	How can we get the police to set up a radar trap?
② Broader:	How can we get the cars to go more slowly?
③ Even Broader:	How can we make sure the drivers are more careful?
④ Broadest:	How can we protect the children from danger along Green Street?

Statements ② and ③ above sound like good problem statements. They would probably help you to think of good ideas like putting up signs or putting bumps in the road to slow traffic. But you might not think of ideas like crossing guards or tunnels under the road until you define the problem in the broadest way possible, like statement ④.

DIRECTIONS:

Use your notebook to rewrite each of the following problem statements in Broad Terms.

1. Complaint: Every time I put the garbage out, the bags get broken into by raccoons.

Problem Statement: How might I catch the raccoons?

FOR A HINT, READ THE BOX BELOW.

To think of a way to rewrite a statement in broad terms, ask yourself, "What is the real problem?"

2. Complaint: The window panes in the new building downtown have started to fall out. Those falling panes are a hazard to pedestrians.

Problem Statement: How might we keep the panes from hitting people?

3. Complaint: Many of the senior citizens living in the Greentree Retirement Home have difficulty going to the shops downtown.

Problem Statement: How might we get a bus to transport these people downtown?

4. Complaint: It's no longer a pleasure to visit our national parks. They're overcrowded and noisy. The trails and campsites are covered with litter. Some people even chop down trees and paint their names on rocks.

Problem Statement: How might we clean up our national parks?

Lesson 4

THE SNOWPLOW PROBLEM

October 29, 1978

Dear Making Changes Class,

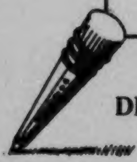
Everybody loves our state in the wintertime. When the snow falls, our roads are filled with people from all over the region who come to enjoy our winter sports. To ready ourselves for these visitors, our snowplows must work through the night clearing snow from the roads that lead to the ski resorts.

With the growing demand for clear roads, the number of accidents involving snowplows has increased steadily. In the course of their work, the plows often tumble into ditches, strike cars and other obstacles that are hidden in snowbanks, and are sometimes hit by automobiles that try to get around them on narrow roads. Every time a snowplow is damaged, the problem of snow removal becomes more difficult.

Can you help?

Sincerely,

Eastern Regional
Snow Removal Association



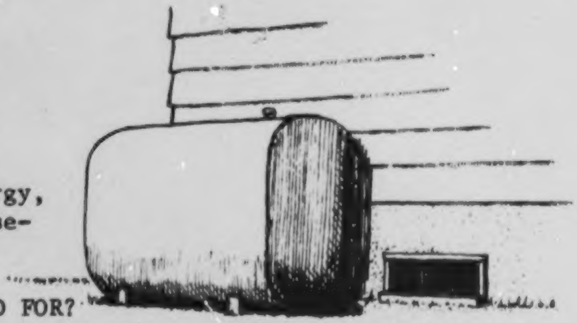
DIRECTIONS:

Define this problem by following the steps given on page 17.

BRAINSTORMING

Practice Problems

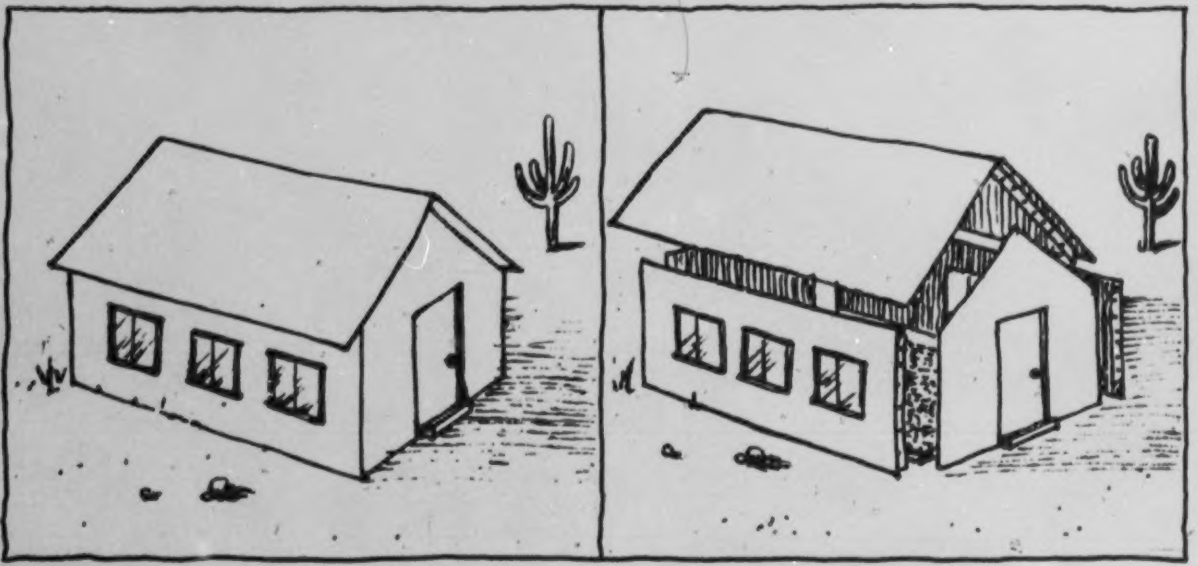
OIL TANK PROBLEM



Oil supplies are running out. New and different ways to heat houses are being found. When a homeowner converts to solar energy, the old oil tank is no longer useful. Or is it?

WHAT MIGHT OLD OIL TANKS BE USED FOR?

TEMPORARY CLASSROOMS PROBLEM

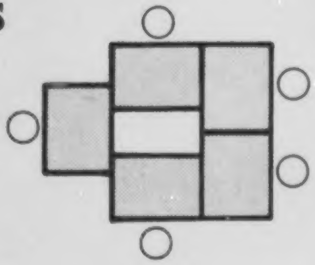


Lesson 5

When schools became crowded, temporary classrooms were put up. Each classroom was built of pieces prefabricated (made beforehand) in a factory. Now, people are having fewer children. Schools no longer need these temporary classrooms. School districts would like to sell them. Advertising would help, especially if the advertisements appealed to many potential buyers by suggesting all kinds of ways to use the prefabricated rooms.

WHAT MIGHT TEMPORARY CLASSROOMS BE USED FOR?

WORKING IN GROUPS



SUGGESTIONS

1. Arrange your desks in a star pattern so that no one is off to one side.
2. Clear your desks so that you have room to work.

GROUP ROLES

1. **Leader:** The leader is the task manager; the leader moves things along and is responsible for making sure that all tasks are done and completed on time.
2. **Recorder:** The recorder takes notes; the recorder keeps a record of the group's progress, especially the ideas generated by the group members.
3. **Reporter:** The reporter reports the results of group work to the rest of the class; the reporter tries to "sell" the group's idea to the class.
4. **Liaison:** The liaison person is the social leader and the "linking agent"; the liaison person makes sure that everyone participates and cooperates. The liaison person also meets with members of other groups as directed.

RULES

1. Everyone should try to cooperate. A group is very fragile (breakable). Everyone should try to participate in activities and refrain from being negative and critical.
2. Each time you are called upon to work in groups, you must fill each of the roles. You may rotate roles or have permanent roles. You may also rotate some roles while others remain permanent.

STRATEGIES

- **Hitchhike:** Use Hitchhike all the time. When someone gives an idea, build on it, improve it. Hitchhiking lets everyone share in an idea.
- **Force fit:** If there is a conflict between two or more ideas, put them together or make another from the best qualities of the conflicting ideas.

THE SCRIPT

To the actors Prepare for this activity by reading the character descriptions below, by skimming over the script, and by choosing roles.

To the audience As you watch the dramatization, pay close attention to:

- Positive behaviors — things that you see the characters do that you think help the group to be productive
- Negative behaviors — things that the characters do and don't do that seem to hurt the group's progress

EVALUATE THE CHARACTERS, NOT THE ACTORS.

The Characters

Honcho:	the leader (a leader should be strong yet not dominate the group; be forceful yet helpful)
Jott:	the recorder (the recorder should keep up with what's going on and still have time to participate)
Link:	the liaison person (the liaison person should encourage participation and cooperation)
Trombone:	the reporter (the reporter should be able to organize the group presentation and sell the group's idea)
Wizard:	an idea genius (most groups will have a person who likes to think up strange ideas but needs to be encouraged)

The Problem Even though the speed limit on the turnpike has been reduced to 55 miles per hour, many drivers are still traveling at speeds of 65, 70, or even faster. Turnpike police do not have enough officers and equipment to fight the speeders. For 200 miles of highway, the troopers have five patrol cars and equipment for only one radar trap.

Script

Honcho: Yesterday we were given a problem to solve. Here's the problem: Even though the speed limit on the turnpike has been reduced to 55 miles per hour, many drivers are still traveling at speeds of 65, 70, or even faster. Turnpike police do not have enough officers and equipment to fight the speeders. For 200 miles of highway, the troopers have cars and equipment for only one radar trap.

Trombone: We know, we know. And we, uh, what-do-you-call-it, uh, broke the problem to pieces and got speed, and police, and drivers and . . .

Honcho: *(interrupting)* Yes, that's right. *(to Jott)* Recorder, would you read the challenge statements, please?

Jott: All of them? *(begins to search frantically in notebook)*

Trombone: Yes, all them, idiot.

Link: Hey, Trombone. No personal remarks, remember...

Trombone: *(interrupting)* Yeh, yeh, "no criticism allowed."

Jott: O.K., challenge statements...*(reads)* "How might we recycle the oil tanks?" ...Oh no, that's a different problem.

Trombone: You know I'm supposed to make a report and I need your notes. If you can't make sense of them, how do you expect me to? *(grins, turning to Link)* See, I didn't criticize.

Link: It was pretty close.

Honcho: Come on, folks. Let's get on with it.

Jott: Yes, here we go. *(reads quickly)* "How might they catch the speeders? How might they get more equipment? How might we slow traffic, control traffic?" ...That's about all.

Link: We had another one. Wizard had a good challenge.

Wizard: I did? Uh, I don't remember.

Link: About safety. Um, something like "How could we make sure drivers stay safely under the speed limit?"

Jott: I'll write that down. *(does so)* And I have one: "How might we reduce speeding?"

Honcho: That's pretty general but nice and short. Let's get some ideas now. If you thought of some last night, start with those.

Trombone: Phony radar traps.

Link: Scare the speeders into going slow.

Jott: Fake accidents.

Honcho: Wizard, any ideas?

Wizard: I can't think of anything...except maybe we could control the speed. We could...

Lesson 6

Trombone: *(interrupting)* Put a speed bomb in the engine.

Link: What's a speed bomb? Could you explain your idea?

Trombone: Like a time bomb except it explodes if you go too fast.

Jott: *(slowly)* You know how the sun makes flowers open? Maybe each car could have a kind of mechanical "flower" that opened when it went too fast. That would warn other drivers.

Trombone: That's dumb. Who'd want to drive a flower down the highway?

Jott: There could be a noise. Something loud in the wheels when the car goes too fast.

Trombone: Flowers! Noises! Next you'll be thinking of smells. *(Changes voice to sound like a perfume advertisement.)* Does your car smell fast? Reduce speed and smell like a rose. The slower you go, the sweeter you'll smell.

Link: Hey, listen. We're not supposed to criticize. Trombone, if you don't like an idea, try to improve it. Otherwise, you're wasting everyone's time.

Wizard: Maybe the tollbooths could... No — forget it.

Honcho: Tell us. Maybe it's a better idea than you think.

Wizard: Well, it's a toll road, right? Say a driver gets on the highway at a tollbooth, and the ticket gives the time, as well as the place...

Jott: *(interrupting)* Hey, yeah! Then when the driver gets off at another tollbooth, the collector checks the time. If the driver went too fast, a higher toll is charged.

Link: Maybe we could reward the good drivers rather than punish the speeders.

Honcho: That's an idea. Write it down.

Jott: Could you all think of shorter ideas? I'm getting writer's cramp.

Honcho: *(looks at watch)* We're running out of time. O.K., everyone, short, quick ideas.

Trombone: Cardboard police cars.

Link: Lights that turn red when a car goes over 55 miles per hour.

Jott: Machines that photograph speeders' license plates.

Honcho: Transistors on the speedometer that get checked every month. How about you, Wizard? What do you think?

Wizard: Uh, I like Link's idea. Drivers who don't speed could get free license plates.

Honcho: We're really cooking now. How about if troopers gave bright orange plates to speeding drivers?

Trombone: That's ridiculous. That would be convicting people without a trial.

Link: Trombone! You're at it again.

Jott: We've got about 20 ideas now, including the ones we thought of yesterday.

Honcho: Let's choose one idea for the report.

Trombone: I like Wizard's idea.

Wizard: My idea will never work. You can't time people on a turnpike because they're always stopping at rest stops and restaurants.

Honcho: *(to audience)* We talked about our "best" ideas, figured out a way to judge them, reworked them a bit and then helped Trombone get the report ready. Here's what we came up with.

Trombone: *(Standing, very pleased to be the center of attention.)* How might we reduce speeding? Well, I'll tell you. The key is to get people to do it on their own. All drivers punch a time clock when they enter the roadway. At the end of the trip, they punch the time clock again. Drivers who keep to a safe speed pay a lower toll than fast drivers. The money we collect from fast drivers could easily pay for gates and time clocks at rest stops and restaurants. Thank you, thank you very much.

Jott: *(Steps up and whispers to Trombone.)*

Trombone: Oh yeah! We could even charge a higher toll for slow pokes who travel at 40 miles an hour or less and cause accidents. That's it. *(to audience)* Feel free to applaud all you want.

CHECKLIST

A *checklist* is a method for thinking of ideas that is useful for improving things — changing them to make them better or more attractive.

ADD OR SUBTRACT SOMETHING?

- Get rid of waste?
- Remove something?
- Make stronger?
- Make a copy?
- Add a layer?
- Exaggerate?
- Add lights?
- Abbreviate?
- Add sound?
- Divide?

CHANGE COLOR?

- Chameleon-colored?
- Remove the color?
- Safety yellow?
- Camouflaged?
- Psychedelic?
- Flat black?
- Striped?
- Silver?
- Plaid?
- White?

CHANGE MATERIALS?

- Recyclables?
- Fiberglass?
- Aluminum?
- Concrete?
- Plastic?
- Rubber?
- Glass?
- Nylon?
- Paper?
- Steel?

CHANGE SHAPE?

- Aerodynamic?
- Cone shaped?
- Egg-shaped?
- Triangular?
- "U"-shaped?
- Free form?
- 10-sided?
- Lopsided?
- Round?
- Dome?

CHANGE SIZE?

- Economy size?
- Microscopic?
- Miniature?
- Thinner?
- Fold it?
- Longer?
- Fatter?
- Higher?
- Lower?
- Wider?

CHANGE THE PARTS AROUND?

- Combine functions?
- Change pattern?
- Turn backward?
- Combine parts?
- Combine ideas?
- Upside down?
- Inside out?
- Split up?
- A blend?
- Coil it?

CHANGE DESIGN?

- From other countries?
  - Eskimo?
  - Indian?
- For other purposes?
  - Education?
  - Amusement?
  - Ecology?
- From other times?
  - Next century?
  - Old West?

Here's an example of how a checklist can be used:

SIGN OF THE TIMES

Dorothy started a new newspaper. She planned to work hard to make the *Sign of the Times* the best paper in the city. But, sad to say, even though its articles and stories were good, people continued to buy the newspapers they had always bought.

"Maybe my paper is too much like the others," thought Dorothy. "Maybe I could make some changes!"

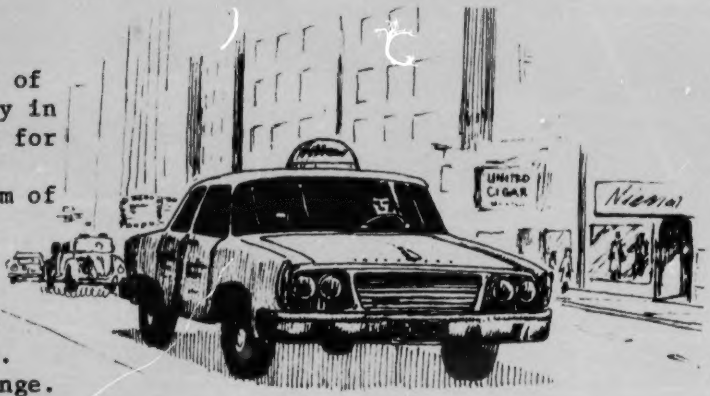
Dorothy used a checklist to help her think of ideas. Here is Dorothy's checklist and some of her ideas.

1. ADD OR SUBTRACT SOMETHING: *Add a shopper's guide. Add some contests. Take out the classified advertisements and print them once a week only. Add more photographs. Add a "people" section.*
2. CHANGE THE COLOR: *Print each section in a different color. Put color photographs on the front page.*
3. CHANGE THE MATERIAL: *Save trees by making the paper out of vegetable fibers. Insert plastic "things to see and do" posters in the Sunday edition.*
4. CHANGE THE PARTS AROUND: *Put the sports section up front. Put a summary of all the major articles on the back page.*
5. CHANGE THE SHAPE: *Make it square. Staple it at the center so the pages don't fall out.*
6. CHANGE THE SIZE: *Cut it down so it's the size of a magazine.*
7. CHANGE THE DESIGN: *Print it by computer. Make it so the print doesn't come off on your fingers.*

Practice Problem

Taxis are a common method of transportation, especially in cities. They can be used for short or long distances. Most taxis carry a maximum of five people.

Can you think of ways to improve a taxi? The taxi of today is quite similar to the taxi of the 1920's. Maybe it's time for a change.



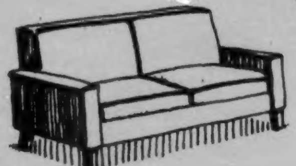
DIRECTIONS:

1. **Write the heading *TAXI CHECKLIST* in your notebook.**
2. **Copy the seven checklist headings, leaving plenty of space between each line for your ideas.**
3. **Then try to think of at least two ideas for improving a taxi under each heading.**

PART-CHANGING METHOD

Part-changing is another method for improving things. With the part-changing method you take an object, explode it into its parts, then try to think of a way to change each part.

Here's an example:



When Herman took over the Acme Couch Company, sales were way down. Herman decided to try to breathe some life into his company by using the part-changing method.

Herman first made a list of all the parts of a sofa.

- Legs
- Seat
- Back
- Arm rest

Then Herman thought of as many ideas as he could for changing each part of a couch.

LEGS: *Put tall bicycle wheels on the sides — put a wheel in front as well and use it as a carriage; put springs on the legs instead of under the seat.*

SEAT: *Fill the seats with water — put fish inside; make it so the seats vibrate; make a clear plastic seat so you can place a book underneath the couch and read in comfort.*

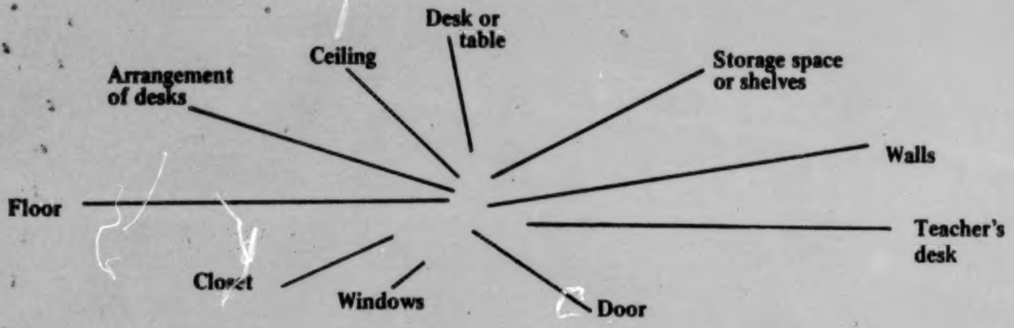
BACK: *Put in fold-down arm rests; attach a reading lamp, stereo head set, fold-down TV set; make the back recline.*

ARM REST: *Make holes for snack trays and drinks; make them removable; connect them with a canopy.*

Practice Problem

You can also use the part-changing method for improving an arrangement of objects like a kitchen, a bathroom or a shopping center.

Suppose you wanted to improve your classroom. First you would want to explode your classroom (on paper). Here is an example of an exploded classroom.


Desk or table
Ceiling
Arrangement of desks
Storage space or shelves
Walls
Floor
Teacher's desk
Closet
Windows
Door

Lesson 7

DIRECTIONS:

1. In your notebook, write the heading *IMPROVING MY CLASSROOM.*
2. List the parts of your classroom.
3. Think of an idea for changing each part that you listed.

FORCE FIT

Force fit is a way of putting things together to come up with new ideas.

- A force fit can be a combination of two things:

clock + radio = clock radio
television + telephone = videophone
motor + cycle = motorcycle

- A force fit can be a combination of more than two things:

pole + rope + ball = tether ball
spyglass + pipe + mirror = periscope
pitcher + electric motor + knife = blender

- Inventors also use force fit when they put two things together to make something completely new:

truck + house = motor home
buggy + skis = sleigh
knife + knife = scissors
rocket + airplane = jet plane

- Sometimes it's possible to make more than one force fit out of two things:

boat + roadway = canal (force a boat on a road)
boat + roadway = ferry, pontoon bridge (force a road on a boat)
boat + roadway = concrete boat, floating tunnel, build a bridge with old aircraft carriers

Lesson 7

Practice Problems

DIRECTIONS:

Try to force fit each of the following items. Each pair has an "answer" – a product presently on the market – but you might be able to think of another force fit as well.

Use your notebook to record or draw your answers, under the heading *FORCE FIT*

camera + developing fluid = ?

library + motor home = ?

bicycle + raft = ?

heating coil + blanket = ?

bank + drive-in movie = ?

fire truck + fruit picker = ?

DIRECTIONS:

Force fit pairs of objects from the list below. Choose any three pairs of objects. Describe your force fit ideas in your notebook.

- suitcase
- wristwatch
- spoon
- snow shovel
- umbrella
- wallet
- alarm clock
- hair dryer
- lamp
- typewriter
- blanket
- drill
- tent
- canoe
- table
- suspenders
- crutches
- camera
- bicycle
- blender
- shower
- book
- baseball glove
- skis
- chain saw
- hat
- desk
- propeller
- fence
- roof
- skateboard
- sewing machine
- fishing rod
- crib
- backpack
- beach ball

Examples:

suspenders + backpack = a safety swing for a baby that's attached to the roof and floor of an automobile

alarm clock + shower = an automatic plant waterer for use during vacations

CHECKERBOARD

A *checkerboard* is a square that can be used to force fit a number of ideas at once.

An example should help you to see how a checkerboard works:

Problem: In many communities, especially in crowded cities, people have time for recreation on weekends but often have nothing to do and nowhere to go. School buildings might be used as weekend recreation centers. But how?

Directions:
1. List some parts of a school building along one side of the checkerboard.
2. List recreational activities — things people like to do — along the top of the checkerboard.
3. Fill in the checkerboard by combining "parts" with "activities."

ACTIVITIES

PARTS OF THE BUILDING	Have fun and meet people	Earn extra money	Learn something
Auditorium	*Hold a game night*	*Put on plays*	*Show films*
Cafeteria	*Church group meetings*	*Have a bake sale*	*Cooking classes*
Gym	*Community dances*	*Have a flea market*	*Teach folk dancing*

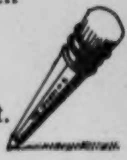
Here's a problem for you to try.

Problem: The population in the United States is increasing by more than a million and one half people each year. Because our state parks and beach resorts are not increasing in number, vacation spots get more and more crowded each year. One suggestion to help solve the problem is to use ski resorts as summer vacation spots.

Directions:

1. Put some of the parts of ski resorts on the left of the checkerboard.
2. Put some ways to have fun in the summer along the top of the checkerboard.
3. Fill in the checkerboard by force fitting "parts" with "ways."

DIRECTIONS TO YOU: Use your notebook to fill in ideas for each square that has a ? in it.



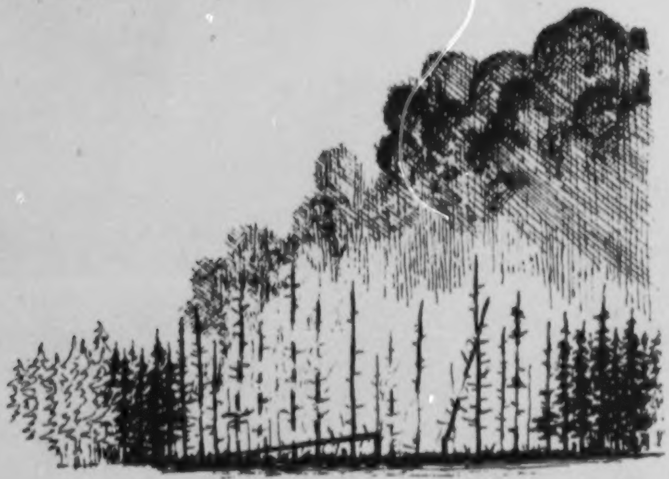
	WAYS TO HAVE SUMMER FUN		
PARTS OF SKI RESORTS	Enjoying the sun	Getting exercise	Excitement – thrills
Ski Slope	*Put giant sun reflectors on the mountain.*	?	*Turn the slope into a giant slide.*
Ski Lift	*Put reclining chairs on the ski lift.*	*Run relay events on the rope tows.*	?
Lodge	*Dig a pool around the lodge.*	?	*Have concerts, have parties at night.*

JUDGING YOUR IDEAS

What does it mean to have a good idea?

Does "good" mean clever, workable, acceptable, or all these things? How do you choose the best idea from among a number of good ideas?

Let's look at a problem.



PROBLEM: Keeping forest fires from spreading.

Fighting forest fires is quite difficult. The biggest worry is keeping the fire from spreading out of control. This is usually done by clearing or wetting a strip of land in the direction that the fire is traveling. If you are successful, the fire will reach this strip and have nowhere to go. You can then concentrate on using chemicals to put out the now-contained fire.

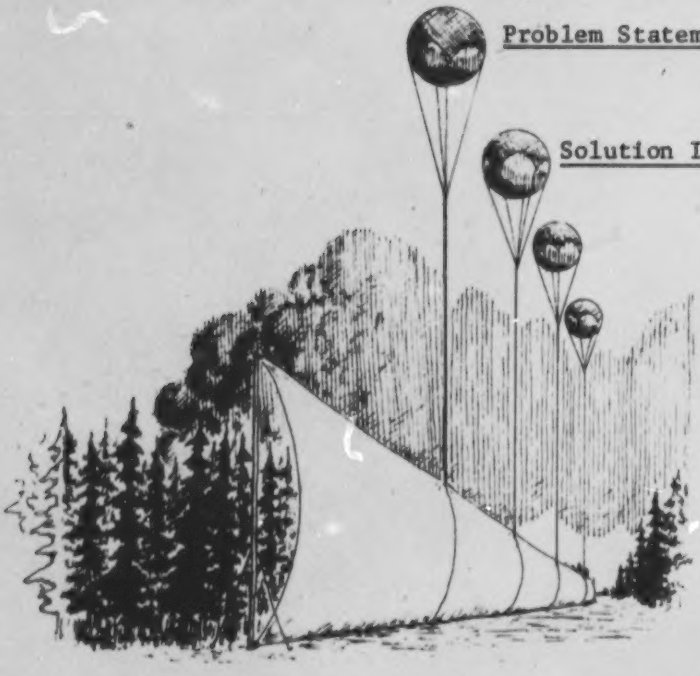
There are some problems with this method:

1. Wind direction can change.
2. Flames or sparks can leap over the strip.
3. Clearing forests takes a great deal of time.
4. Some forests cannot be reached easily by the work force and equipment needed to do the stripping.

Lesson 8

38

Here's an example of a problem statement and a solution idea.



Problem Statement: How can we keep forest fires from spreading?

Solution Idea: *Fire Sails.* Suspend large sheets of fireproof material from hot air balloons. The hot air from the fire would keep the sails in place. The sails would also provide for a reverse flow of air to block the path of the fire.

How could you judge this idea? The chart below lists CRITERIA that can be used for judging ideas. Criteria are standards that an idea must meet in order to be judged as a "good" idea. For each criterion (the singular form of criteria) it is possible to ask a question. Answers to the fire sails idea are below.

CRITERIA	QUESTIONS	ANSWERS
1. COST	Is it expensive?	*Can't tell if it's too expensive.*
2. WORKABILITY	Will it work? Will it solve the problem?	*Yes. It looks like it would work.*
3. ACCEPTABILITY	Will people accept it?	*Yes.*
4. RESOURCES	Are the resources and materials available?	*Yes.*
5. CONSEQUENCES	Will it work without producing undesirable consequences?	*Yes, no harmful consequences will result.*

In order to see how several ideas compare on the different criteria, we will use a CRITERIA CHART.

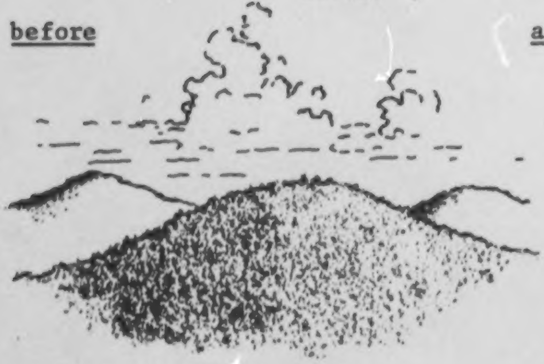
The "P" stands for "pass."

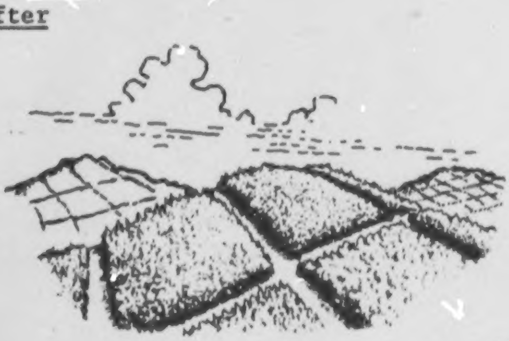
IDEAS	COST	WORKABILITY	ACCEPTABILITY	RESOURCES	CONSEQUENCES
1. Fire Sails	?	P	P	P	P

The fire sails idea passes on four criteria. More information would probably be needed before the cost criterion could be judged. Let's look at another solution idea.

PROBLEM STATEMENT: How can we keep forest fires from spreading?

SOLUTION IDEA: *Fire Streets*. Divide forests into squares. Cut "streets" throughout the forest. Pour cement on the "streets" to prevent the growth of plants and trees. Make the "streets" wide enough so that flames cannot cross.





HOW WOULD YOU JUDGE THIS IDEA?

DIRECTIONS:

1. **Draw a *CRITERIA CHART* like the one above in your notebook.**
2. **Judge the "fire streets" idea. If the idea passes on a criterion, put a "P" on your chart below the criterion. If the idea fails on a criterion, put an "F" on the chart below the criterion.**
3. **For each "F" you have placed on the chart, write a sentence that explains why the idea failed and how the idea might be changed to make it pass.**

SEESAW PROBLEM

The lesson you will be doing in the next session is called a SEESAW problem. It is like a "seesaw" because you will be going back and forth between a problem in your Lesson Book and a problem in your notebook. The problem in the Lesson Book has been worked on and solved for you. The problem in your notebook is yours to solve.

Read each step in the problem that follows this page. Read these pages for homework. Make sure you complete the reading by the next class. Pay careful attention to the problem-solving steps.

At the next *Making Changes* session, your teacher will give you several pages for your notebook. The pages will look like the pages that follow in this Lesson Book except that the answer spaces will be blank. These pages for your notebook will present a problem that you will define and try to solve. You and your group will be responsible for proceeding through all the steps that are presented on the following pages.

A1 THE MESS

October 29, 1978

Dear Students:

Last night someone stole a metal hoop from the playground. Last weekend someone threw paint on the tool shed. Something new is graffitied on the school building or the sidewalk almost every day.

Not a month goes by without a broken window. The bike shed looks like a colonial fort from being carved, chopped, and burned. It's your problem as well as mine. Can you come up with a solution?

Your principal,

John K. Archer

John K. Archer

P.S. We can only afford to pay $5,000 a year for a solution.

A2 PROBLEM STATEMENTS-CHALLENGES

Write the problem as a Challenge using three methods. Try for two statements for each method.

How? *How can we get rid of the graffiti?*

Now try another How?. Look at the problem in a new and different way.

How can we catch the vandals?

Verb Change *How can we clean/guard/seal off the school?*

Reversal *How can we make students respect the school building?*

How can we make the vandals want to stop their vandalism?

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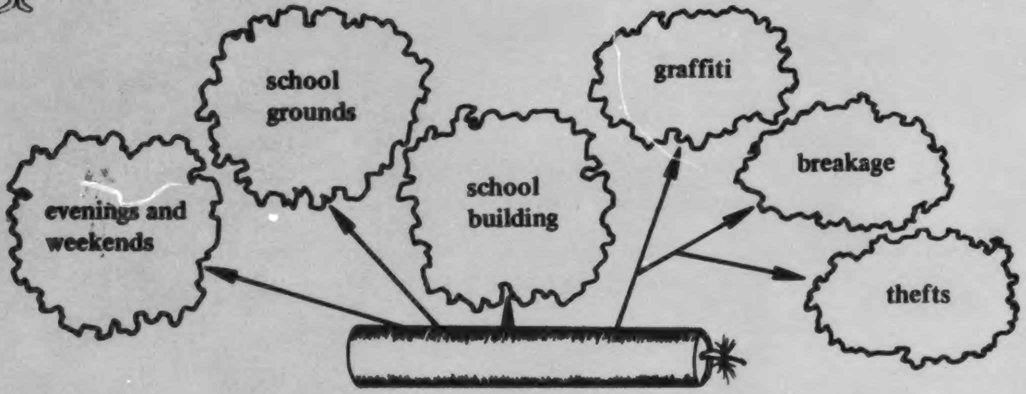
A3 EXPLOSION

Explode the problem into parts — the things that make the problem worse.


school grounds
graffiti
breakage
evenings and weekends
school building
thefts

A4 FINAL PROBLEM STATEMENT - BROAD TERMS

Select a statement from A2 or write a new one based on A3 that fully defines the problem in its broadest terms.

How can we prevent vandalism to school property?

How can we make people be more responsible about school property?

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A5 INDIVIDUAL BRAINSTORMING

Recall what you learned about brainstorming. Use your imagination. Try to think of at least five ideas.

1. *A fence*
2. *A moat with alligators*
3. *Bright stadium lights*
4. *Cameras like those in banks*
5. *Cameras set off by sound or touch*
6. *Get some German shepherds*
7. *Make stiffer penalties for vandals*
8. *Find a cheap guard*
9. *Move the police station closer*
10. *Brainwash students*

CIRCLE YOUR FAVORITE IDEA.

A6 GROUP BRAINSTORMING

Brainstorm ideas with your group. Tell your favorite idea from A5. Think of more. Write down new ideas.

1. *Make students responsible for school property*
2. *Have a community patrol — a posse*
3. *Reward students if vandalism stops*
4. *Have teachers take turns sleeping at school*
5. *Turnstiles — to get on the grounds, students have to show special cards*
6. *Have plainclothes student spies*
7. *Get rid of all vacations*

A7 CHECKLIST & PART CHANGING

Work with a partner to think of ideas using a checklist. Look back at A3 and A6 for ideas of things to change.

ADD OR SUBTRACT SOMETHING *Take away those things that are vandalized most.*

CHANGE THE MATERIAL *Cover the grounds with graffiti-proof paint.*

CHANGE THE PARTS AROUND *Put the playground on the roof.*

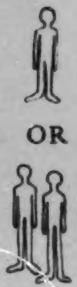
CHANGE THE DESIGN *Put the school grounds inside the school.*

Next, list the parts of the object or system you wish to improve. List ideas for changing each part.

PLAYGROUND	*Put a fence around the playground.*
TOOL SHED	*Cover the tool shed with washable aluminum siding.*
BIKE SHED	*Get an iron bike rack.*
WINDOWS	*Put up steel screens.*

A8 CHECKERBOARD

Try different checkerboard ideas:



WAYS TO PROTECT THINGS

PARTS OF THE PROBLEM

	FENCES	OUT OF REACH	ALARMS	GUARDS
SCHOOL BUILDING WALLS	*Cover the first floor with a fence-like wall.*	*Put unclimbable obstacles around the walls.*	*Put phony alarm decals on all the windows.*	*Put a dummy in a guard's uniform at one window.*
PLAY-GROUND	*Put a fence around the playground only.*	*Raise the playground. Take away the stairs when school closes.*	*Wire the equipment with alarms.*	*Put scarecrows in the playground.*
BIKE SHED	*Get rid of the bike shed. Students can chain bikes to a fence.*	*Put the bike shed on the roof.*	*Fix alarms that light up if anyone comes at night.*	*Chain a German shepherd to the bike shed.*

A9 HITCHHIKE

Work with your group to hitchhike ideas you have so far.

1. *Put up lights → walls of lights → photoelectric beams that trip alarms*

2. *Cheap guards get dogs → put them inside → get loud barkers → put them outside in pens*

3. *Cheap guards → people to live on school grounds → get college students*

4. *Move police station → have some night activity → all-night gas station*

5. *Make students responsible → have a volunteer "army" → pay these students from the maintenance budget but make them pay for any damage*

A10 FORCE FIT

Put two or more ideas together to form a new and better idea.

Stiffer penalties *Move the police station* *German shepherds*	⇒	*When you catch vandals, give them a dog and badge and make them patrol the grounds for six months*
All-night gas station *Cheap guard*	⇒	*Hire a guard to tend the gas station and watch the grounds*
Make students responsible *Have "live-in" couple*	⇒	*Have pairs of seniors take turns living on school grounds rent-free, no salary*

A11 CHOOSE AND ELABORATE*

**Elaborate* means to give details, to expand, to decorate, to improve, and to describe your idea fully.

1. Go back and circle the ideas that you like best.
2. Elaborate one idea on your own.
3. Elaborate at least one other idea with your group.

LIVE-IN-PEOPLE ON SCHOOL GROUNDS — you could advertise — maybe somebody with a trailer would like free rent and electricity. Maybe you could have experimental live-ins using pairs of seniors or college students.

THE VOLUNTEER ARMY IDEA could work like this — a volunteer force of 50-75 students is formed and duties are divided among the volunteers. Patrols are formed, especially on nights of sporting events. If the patrols prevent vandalism, they get scholarships or awards. If not, they must pay for the damage.

THE GAS STATION IDEA — there's a gas pump in front of the maintence shed —just get a cash register and put up a sign. Hire somebody, pay him or her out of the profits, and make the attendant responsible for keeping an eye on the grounds.

Lesson 9

A12 JUDGING YOUR IDEAS

1. List up to five of your favorite ideas on the criteria chart.

2. From the box select criteria that apply to your problem. List these criteria in the spaces at the top of the chart. Add other criteria if you wish.

COST: Do we have the money to do it?	RELIABILITY: Will it last, can you count on it?
ACCEPTABILITY: Will people like it and accept it?	WORKABILITY: Will it work, will it solve the problem?
RESOURCES: Do we have the people, the material, and the time to do it?	CONSEQUENCES: Will it have a harmful effect on people or events?

3. Fill in the chart. Place a P (pass) or an F (fail) under each criterion. Rate all your ideas in the same way.

IDEAS	WORKABILITY	RESOURCES	ACCEPTABILITY	CONSEQUENCES	COST		EXPLANATIONS
1. *Put up a fence*	*P*	*P*	*P*	*F?*	*P?*		*We decided that we didn't want the school to look like a prison.*
2. *Increase vacations*	*P*	*P*	*F*	*P*	*P*		*Vacation days are determined by state law.*
3. *Live-in couple or students*	*P*	*P*	*P*	*P*	*P?*		*We decided that we could reduce the cost enough to make it pass.*
4. *Volunteer patrols*	*P*	*P*	*P*	*P*	*P*		
5. *Gas station*	*P*	*P*	*P?*	*P*	*P*		*We decided that the school board would accept it if it saved them money.*

A13 PUTTING YOUR IDEA INTO ACTION

It is all well and good to have a clever idea, but it won't help you or the world if you can't put it into action. Use your imagination to think of ways of getting your idea accepted.

WRITE THE GROUP IDEA HERE: *Live-in couple*

1. List the advantages that go with your idea. Describe how you would strengthen each advantage.

2. List the problems, obstacles, or objections that go with your idea. Describe how you would overcome these obstacles or objections.

ADVANTAGES	HOW TO IMPROVE OUR IDEA
At cost equal to or below present cost of repairs	*Cost would be lower if couple owned a trailer and school paid utilities*
Give a young couple a place to live	*If couple were poor (e.g., college students or disadvantaged), even better*
Couple would not be police; would warn vandals first time, may even help vandals to be better people	*If couple were young, street wise, and really knew kids, then they'd be respected and trusted*

OBSTACLES/OBJECTIONS*	HOW TO OVERCOME THEM
Need zoning permission from town council	*Have school board convince town council*
Need couple acceptable to students, school board, and community	*Make up interviewing committee with equal representation from all three groups*
If couple owns trailer, they may want more than free utilities	*Can offer monthly bonus if couple is effective. Bonus to be not more than ½ repair costs, i.e., up to $200 a month.*

***OBJECTIONS** — Reasons why your idea would not be accepted; criticisms of your idea; problems you'd have to solve before your idea could be put into practice.

A14 PRESENTING YOUR IDEA

The final task is for your group to present your idea to the rest of the class.

Discuss how you will present your idea. Make your presentation as original and creative as your idea. Discuss what criteria and advantages you will emphasize. Anticipate questions by telling how you will overcome obstacles.

Never before in the history of humankind has so much come from so few. It is your privilege and honor to be the first to hear a sensational idea. Our idea is to advertise for a young couple with a trailer who would like to have free rent and electricity in return for keeping an eye on the school grounds at night and on weekends.

This solution will work because *vandals won't try anything if they think they are being watched. The idea will be accepted if we let students, the school board, and the community help with the selection of the couple*.

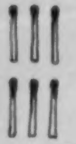
Our idea is an exceptionally good one because *if we pick a young street-wise couple, they could become our friends. If they are well respected, they could get kids to improve, not just protect, the school grounds. And one more thing, it will save a bundle*.

If anyone in the room would like to learn to be as clever as we are, private lessons can be arranged for a small fee. Thank you.

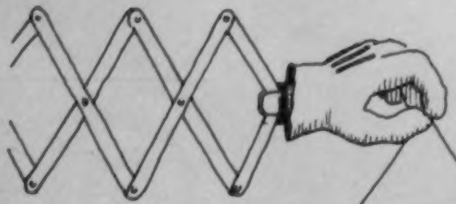
THINK OF TEN USES FOR

A. Old Airplanes
B. Old Warships
C. Old Mattresses

Design a bus that would hold more people than present buses and would be easier to enter and leave.



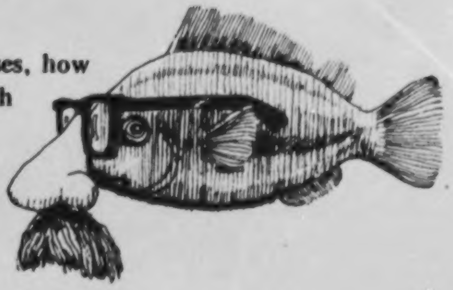
MAKE A TRIANGLE WITH 6 MATCHES

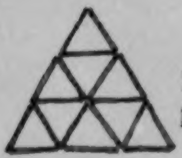


Design a wheelchair attachment for opening doors.

Design a revolving door for wheelchairs

Aside from disguises, how can we protect fish from overfishing?





Remove five sticks so that four triangles remain.

DESIGN A 'DOORBELL' FOR THE DEAF.

DESIGN A PLANT WATERING MACHINE

DESIGN A SAFE APARTMENT HOUSE

For ten seconds, try not to think about hamburgers.

Design baby clothes that will grow with the baby.

Design A Nutcracker that won't crush the nut.

MAKING CHANGES

OBJECTIVES – UNIT II

What you should be able to do when you complete each lesson of Unit Two:

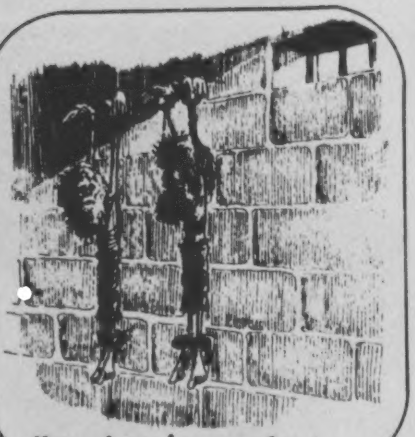
Lesson 10
- Know at least four reasons why FUTURES STUDIES is important.
- Know some possible developments that might occur in the near future.

Lesson 11
- Be able to judge FORECASTS according to four criteria: EXPERTISE, BIAS, RECENCY and CONSISTENCY WITH KNOWN FACTS.
- Know what a TREND is; be able to identify factors that affect trends.
- Be able to "read" GRAPHS and tell what they mean.

Lesson 12
- Know what an ACCELERATING TREND is.
- Be able to define and explain the use of a CROSS-IMPACT MATRIX.

Lesson 13
- Be able to use a Cross-Impact Matrix to construct forecasts.
- Be able to identify sub-problems, write challenge statements and generate solutions to a major world problem.

FUTURES STUDIES



Now, here's my plan...

WHY SHOULD I STUDY THE FUTURE?

Because you're going to spend the rest of your life in the future — more than half of your life will be in the 21st century.

Because the future is sure to bring new problems that won't take care of themselves.

Because studying the past may not be enough to prepare you fully for a changing world.

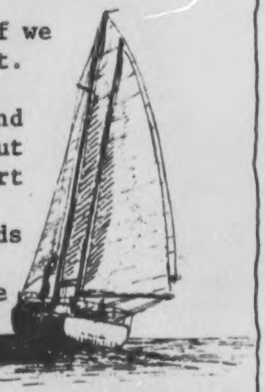
HOW DO YOU SEE THE FUTURE?

The future is like a roller coaster!

We're rolling along through time as if we were on a roller coaster. There are turns and hills and valleys and dark mysterious tunnels, but the course is fixed. We can't get off.

The future is like a sailboat!

We're traveling through time as if we were on a sailboat. We often have to follow currents and changing winds, but we're free to chart our own course. Sometimes the winds slow and so does our speed, but the direction is ours to control.



Do you know where we're headed? How much time do you spend thinking about what you or the world will be like five or 50 years from now?

If you are like most people, almost all of your thoughts are about the present or the past.

Of course, you say. What's the point in thinking about things that haven't happened yet? The next few pages will give some answers to that question.

Lesson 10

This reading and the ones that follow will give you some practice in thinking about the future. You will be learning some of the methods used by futurists* to make forecasts** about the future. Later you will learn to use these methods to look for solutions to problems.

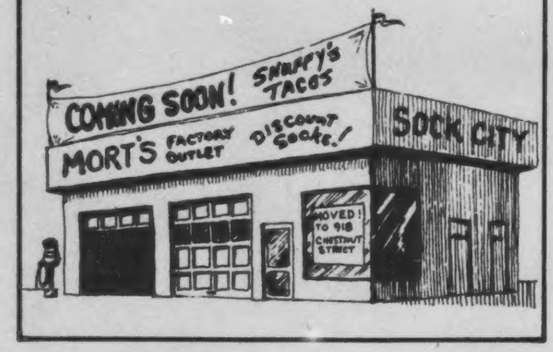
* **FUTURIST** — one who makes a study of possible futures. A futurist tries to identify future problems and plan ways to avoid these problems.

** **FORECAST** — a statement about a future possibility.

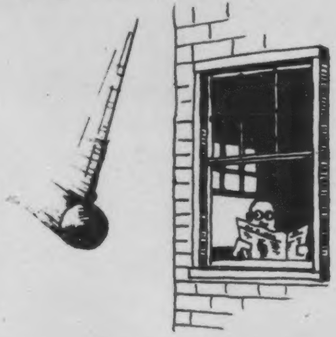
Before discussing what futurists do, it is necessary to understand why forecasting and futures studies are important activities.

Here are four of many reasons for studying the future:

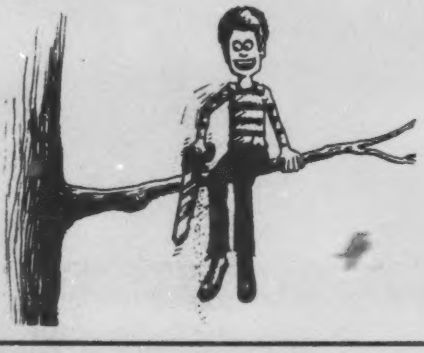
1. To be prepared for rapid growth and change.


COMING SOON! SNUFFY'S TACOS
MORT'S FACTORY OUTLET
DISCOUNT Socks!
SOCK CITY
MOVED! TO 918 CHESTNUT STREET

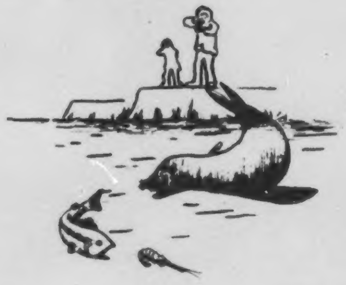
2. To head off problems before they occur.



3. To look for long-term solutions to long-term problems.



4. To become aware of systems — how things are connected to one another.



Let's look more closely at these four reasons:

1. To be prepared for rapid growth and change.

Whatever the world of the future is like, it is sure to be different from the world as we know it. We cannot prepare for a world of the future by studying the past alone.

FACT: Ninety percent (90%) of all the scientists who have ever lived are alive today.

FACT: It took 112 years between the discovery of photography and its application, 56 years for the telephone, 12 years for television, 3 years for transistors...

FACT: Of all the books produced since the beginning of history, more than half were written in the last 50 years.

Rapid growth and a rapid expansion of knowledge mean that our values* may also undergo rapid changes.

One of the ways to prepare for a changing world and to avoid "future shock" is to learn about the kinds of changes that may occur.

2. To head off problems before they occur.

Futurists agree that we can no longer afford to wait for problems to get serious before we try to do something about them.

FACT: If they continue at their present rate of growth, the populations of Asia, Africa, and South America will have more than doubled in 30 years. By that time, they will need twice as much of everything they have now -- twice as much food, twice as many houses, etc., just to keep their present standard of living.

FACT: Growth in world food production has not been increasing to meet the demand produced by this population growth.

FACT: We've consumed as much energy over the past 15 years as was used in all of history before that period. Many scientists believe that if we continue the way we have been going, the U.S. will be completely out of oil, gas and coal in just 50 years or so.

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*VALUES -- What one believes to be important about people and life.

No one likes to think about the population problem or the "explosion" as it has been called. No one likes to think about the destruction of the environment, or crime, or poverty either. It is more comfortable to think that these problems will go away or be solved by governments or scientists when they get to be really serious.

More and more we have begun to realize that if we wait, problems may develop that we will be unable to solve.

3. To look for long-term solutions to long-term problems.

The United States is famous for being able to respond quickly to problems. Forming the Peace Corps and putting a man on the moon are examples of short-term plans that were carried out quickly and successfully.

But many problems demand long-term solutions — solutions that will continue to work and continue to insure a pleasant world for 20, 50, 100 years and more.

FACT: Millions of dollars have been spent on security measures and police patrols in schools. Nevertheless, a survey taken in 1973 showed an 85.3% increase in assault (criminal attack) on students and a 77.4% increase in assault on teachers over a three-year period.

FACT: It has been estimated that in the 20 years since DDT (a chemical used to get rid of pests) was put on the market, 500 million deaths due to malaria have been prevented. But because DDT can build up in plant and animal life, it poisons food supplies. DDT has been banned in the U.S., but it takes about 11 years for it to disappear from the food chain.

To become good at long-term planning we must learn how to think ahead, to identify possible problems. And we must be able to identify the consequences of different actions we might take.

4. To become aware of systems – how things are connected to one another.

People in all societies find it easiest to solve problems one at a time as they appear. Recent ecological disasters or near disasters have taught us that we live in a complex "eco-system" where one problem cannot be separated from another. We cannot propose a solution to the "energy crisis" without considering the effect of that solution on the social system, the physical environment, and international politics.

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FACT: A plan for building fisheries in Scotland was blocked *because* the shrimp eggs to be used for food were no longer available from the U.S. *because* the shrimp population had "eaten" chemicals that had spilled into the water *because* U.S. farmers used these chemicals to stop insects from eating their crops.

FACT: Improvements in household detergents can threaten the tourist industry in lake regions. Phosphates in detergents remain in the water after the water is used for laundries. If this water is released into a lake, the result is often an increase in algae and eventually an algae-choked lake.

FACT: In October of 1976, residents of Philadelphia, Pennsylvania and surrounding areas were warned to wash fruits and vegetables carefully. The reason for the warning: Possible radiation fallout from an atomic test conducted 7,000 miles away in the People's Republic of China.

As nations come to depend more on one another for food and resources, the necessity for a "global awareness" increases. Boycotts of oil in the Mid-East, crop failures in Russia, overfishing in Peru, the use of certain aerosol spray cans in the United States can have a far-reaching effect on the daily lives of people all over the world.

This growing interdependence* of nations means that we must consider the effects of our decisions on the rest of the world before we carry them out.

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*INTERDEPENDENCE -- The condition of being dependent on and influenced by each other.

WHAT CAN BE DONE?

None of the problems facing the world today appears to be unsolvable. Yet, many people sincerely believe either that the situation is hopeless or that there is nothing that they can do.

It is quite possible that the single largest obstacle to effective planning and "futures" problem solving is the belief that there is nothing that the average person can do about the future.

One futurist has put together a list of things that students can do about the future. Here are some of the ways of thinking that may help you to become a "futurist."

- View the future as a set of alternatives -- Instead of thinking about The Future, think about choices or possibilities.

  Look to the future, not as what will happen but as what could happen.

- Believe in "people power" -- For example, a small group of activists were able to stop construction of the American supersonic transport.

  You can't and won't change the future unless you believe that you have the power to make those changes.

- Be inventive -- Don't accept what others say will be. Imagine, invent, design your own future.

  Look at things in a new and different way.

In short, this futurist and others believe that it makes good sense for everyone to become a futurist.

IDEAS ON THE FUTURE

What might the future be like in years to come? How might your life be different from that of your parents? Here are some forecasts and possibilities to consider.

POPULATION

Control of the aging process may be achieved through such techniques as hormone replacement therapy.

Advances in "cryobiology" may permit people to be preserved indefinitely (frozen) in a state of suspended animation.

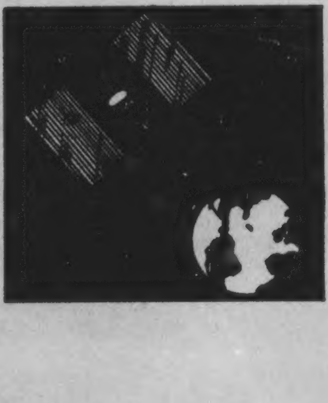
SPACE

Space colonies of the future might consist of two connected cylinders containing 100 square miles in total land area. The most beautiful areas on earth might be duplicated in them.

By 2150 there could be more people living in space than on earth. Earth might serve mainly as a tourist attraction.

ENERGY

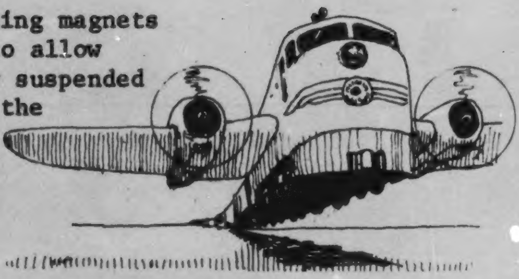
Satellites might be used to collect solar energy. Solar cell collectors would convert solar energy to microwaves which would be beamed down to earth and transformed into electricity.



Floating towns of the future may have all of their energy supplied from wave power.

TRANSPORTATION

Super conducting magnets may be used to allow trains to fly suspended a foot above the ground at speeds up to 300 mph.



Transportation will become more varied: motorized chairs, moving sidewalks, capsule cars, on-call transport, and monorails interconnected with office buildings.

TECHNOLOGY

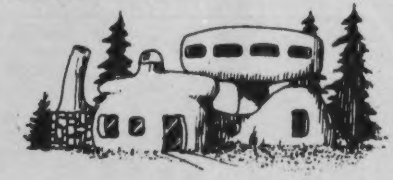
Computers will be developed that understand standard intelligence tests and score at the genius level or above.

Briefcase-size translating machines that allow two people who speak different languages to communicate with each other may exist in the year 2000.

HOUSING

Buildings of the future will be built largely of aluminum, glass and plastic. Windows will automatically darken as the sun shines on them and transparent glass will turn opaque at the touch of a knob. Movable plastic walls will allow rooms to be rearranged.

Portable housing units that plug into core structures may be common in the year 2000.



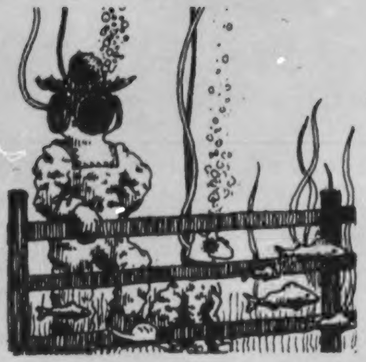
BEHAVIOR

Psychochemicals and surgery may be used to modify the behavior of criminals.

By 1985 it may be possible for anyone to change his or her mood by taking the appropriate pill.

FOOD

Aquaculture (fish farming) may become quite common. Fish and shellfish can be grown up to five times faster than in nature.



By the year 2100 over 5% and by the year 2500 over 50% of all human food will be synthetic.

WORK

Because of rapid change, skilled workers may have to attend school at least four times in their lifetimes to be totally retrained for new jobs.

There may be an increase in career counselors, career change advisors, and family planning consultants — people might go to these counselors for help in much the same way that people of today go to doctors or lawyers for advice.

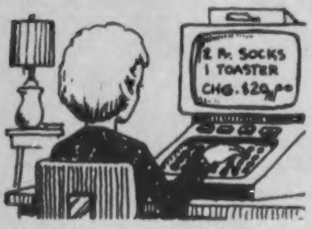
COMMUNICATIONS

Full color, wall size TV sets that are no more than two inches thick and miniature TV's that fit on watchbands may be available in the not too distant future.

By using laser techniques, images of full newspaper pages may be transmitted across thousands of miles in seconds.

COMMERCE

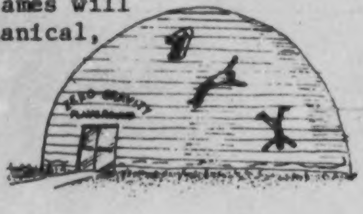
By the year 2200 most retail buying of convenience goods may be done by computers which connect each home with the nearest retail store.



Money may disappear as a means for the transfer of goods and services. Customers will have cards that transfer funds automatically to a storekeeper's account.

RECREATION

New sports such as submarine racing and airborne lacrosse will involve our ability to go under water and into the air. Games will become more mechanical, electrical, and challenging.



In the future, people may be able to experience life in the past. Computer experts may join with historians, designers and museum specialists to create an environment that closely resembles King Arthur's court, a Plains Indian village or ancient Greece.

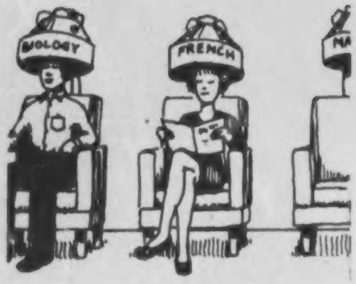
HEALTH CARE

By the year 2025 we may be able to stimulate the growth of new organs and limbs in human beings.

Early in the next century, medical scientists may be able to modify genes through molecular engineering to overcome human hereditary defects.

EDUCATION

Drugs may be developed and used to increase the learning speed of slow learners.



Machines for instant learning may be developed. They will have program tapes that plug directly into the nerve cells of the brain. People will be able to learn subjects such as French without consciously trying.

DIRECTIONS:

Write answers to the following questions in your notebook under the heading *FUTURES STUDIES.*

1. Why do you suppose the title of this section is *Futures Studies* instead of *Future Studies*?

2. Do you think that the future is like a roller coaster or like a sailboat? If you can think of another way to describe the future, do so.

3. Define *FUTURIST* in your own words.

4. What does *GLOBAL AWARENESS* mean? (Look back at page 55 for a hint.)

Each of the numbered paragraphs below is an example of a reason for studying the future. Match the reasons to the examples by placing a letter (A, B, C or D) next to each number in your notebook.

A. *Be prepared for rapid growth and change*

B. *Head off problems before they occur*

C. *Look for long-term solutions*

D. *Become aware of systems*

5. An estimate done in 1968 showed that if we continue using natural resources at our present rate, the world will run out of mineral resources quite soon.

Silver — 1990
Uranium — 1995
Tin — 1995
Nickel — 2100
Copper — 2025

6. More than 2.5 million people live on Long Island, New York. To leave the island, it is necessary to take a bridge or a tunnel. As more people move to the island, new bridges and roads are needed to ease the congestion. But whenever a new bridge is built, more people are encouraged to move to the island and the traffic jams become worse than before. There isn't any space left for new roads; money is not available for new bridges or tunnels.

7. It used to be that a person held one job for life. Later, people began to change jobs once, sometimes twice in their chosen profession. Now it is common for people to change jobs, move from one part of the country to another, even change occupations many times in their lives.

8. A popular "cure" for the energy crisis is solar energy. But most people who have confidence in this solution don't realize what this solution would require. Switching to solar energy would require a revolution in housing construction as well as great quantities of raw materials like copper, aluminum and tungsten which are now in short supply.

FORECASTING THE FUTURE

This section is about *FORECASTS* and how they are made. Forecasts are statements about future possibilities. They are based upon present facts and upon a careful analysis of the direction in which the world seems to be headed. *(fore* = early / *cast* = estimate).

Here are two examples:

- It seems likely that there will be a continuing decline in racism in the last quarter of this century and an increase in cross-ethnic marriages.
- Zero population growth may be achieved as early as 1990 in the U.S.

You are probably familiar with forecasting in the form of weather reports. From your experience with weather forecasts, you know that they are "best guesses." They are usually accurate, but they are never certain. And the further into the future you forecast, the more uncertain the forecast will be.

In this lesson, we're going to look at three ways forecasts are made:

BY INDIVIDUALS

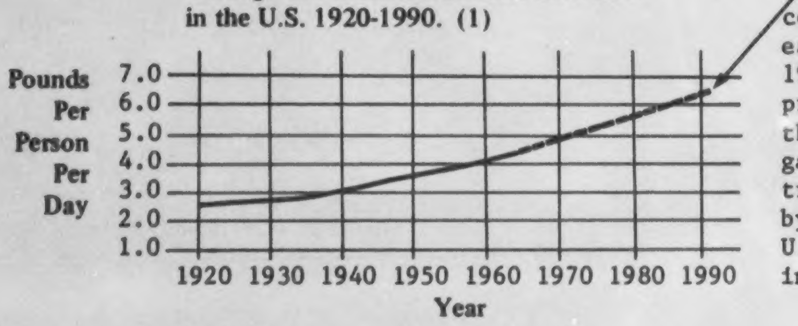
> "James W. Wilson, Harvard professor of Government and an expert on crime, expects city crime rates to keep rising for a few years more and then fall..."
>
> *Wall Street Journal*, April 6, 1976.

BY GROUPS

> "A New York research group predicts (forecasts) that 40% of all Americans in the year 2020 will live in metropolitan areas of more than 2.5 million people..."
>
> *Wall Street Journal*, April 6, 1976.

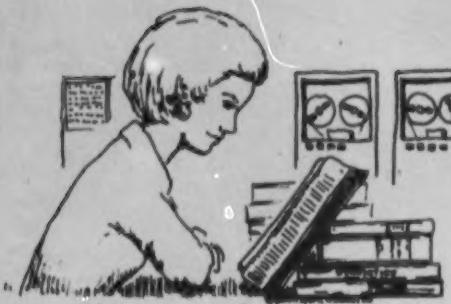
BY EXTENDING TRENDS

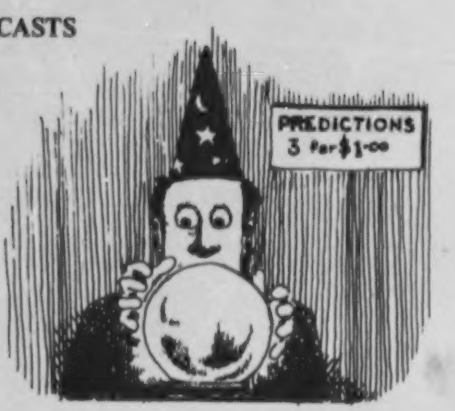
Garbage and Trash Production Per Person in the U.S. 1920-1990. (1)



If the trend continues, each person in 1990 will be producing more than twice the garbage and trash produced by the average U.S. citizen in 1920.

INDIVIDUAL FORECASTS





- Futurists do not "see" the future. They do not have special powers or "crystal balls."
- Futurists do not predict the future. They forecast possible futures. (A prediction is a statement about something that will definitely occur.)
- A good forecast is one that is consistent* with all the known facts. A good forecast describes a strong possibility.

HOW CAN YOU JUDGE FORECASTS?

Since futurists can be wrong and forecasts can contradict one another, it is important to be able to evaluate or judge forecasts.

Here are four criteria for judging individual as well as group forecasts:

1. EXPERTISE*	Is the person an expert? Usually, the best forecasts are made by people who are in a position to know.
2. BIAS*	Is the person or group unbiased? Sometimes, when a person or group has something to gain from a forecast, you may want to check it further before accepting it.
3. RECENCY*	Is the forecast a recent one? Recent forecasts may be more accurate than old, out-of-date forecasts.
4. CONSISTENCY*	Does the forecast match what you know about the subject? Do you know any facts or trends that contradict the forecast? Are other conclusions just as likely?

On the following page are six individual forecasts for you to judge.

---

*CONSISTENCY — In agreement with, fits with, matches.
EXPERTISE — Expertness, "know-how."
BIAS — Prejudice, opinion based on personal gain.
RECENCY — "Newness," the quality of being recent.

Lesson 11

JUDGING FORECASTS

DIRECTIONS:

In your notebook, write the heading *JUDGING FORECASTS*. Then write the names of the four criteria: *Expertise* *Bias* *Recency* *Consistency*

①A. "In the year 2000, mainly disposable clothing will be worn."

Ronald S. Bard, Vice President of
Scott Paper, 1969.

B. "Clothes for both men and women will be almost identical, and plain, but dressed up with hats, scarves or flamboyant belts."

John Kettle, author, 1970.

Why might forecast B be more trustworthy than forecast A? Give an explanation that uses one of the four criteria.

---

②A. "By the end of the century, 90-95% of all Americans will live in urban areas."

Hal Hellman, author, 1970.

B. "People are leaving the urban centers and moving to rural areas. A post-industrial age may be at hand."

William N. Ellis, author, 1975.

Why might forecast B be more trustworthy than forecast A? Give an explanation that uses one of the four criteria.

---

③A. "We will not escape a Civil War — another dreadful conflict setting neighbor against neighbor."

Jeane Dixon, astrologer, 1976.

B. "Fifty years from now...thousands of people in government... spending their lives and our money doing work wiich makes almost no sense at all."

Lawrence Peter, political economist,
1976.

Why might forecast B be more trustworthy than forecast A? Give an explanation that uses one of the four criteria.

GROUP FORECASTS

Some forecasts are made by individuals and some are made as a result of questioning a group of experts. The opinion of a group is not necessarily any better than any individual's opinion. However, for important issues like the future of the "energy crisis" or international relations, it makes good sense to ask more than one person for their opinions. Many futurists feel that group forecasts are more trustworthy than forecasts made by individuals.

One kind of group forecast is called the *DELPHI* (pronounced with a long i).

The Delphi is a way of collecting opinions from a group of experts so that everyone has a chance to contribute his or her independent views and to consider all the important facts. The Delphi is something like a poll and something like a meeting.

Below are two examples of Delphi forecasts.

A. The LTV Delphi was conducted in 1968 by LTV Electrosystems, Inc.:

Development	Most Probable Date of Occurrence
Supersonic transport aircraft will be in regular service over land areas in the U.S. by	1982
Baldness and loss of hair will be overcome by simple drugs or other treatments by	1990

B. In 1973, 40 experts on energy and the environment responded to a Delphi designed by Vaclav Smil (University of Manitoba, Winnipeg, Canada):

Development	Most Probable Date of Occurrence
Effective population control by.	2000
Widespread use of geothermal power by.	2020
Private cars banned by.	Never

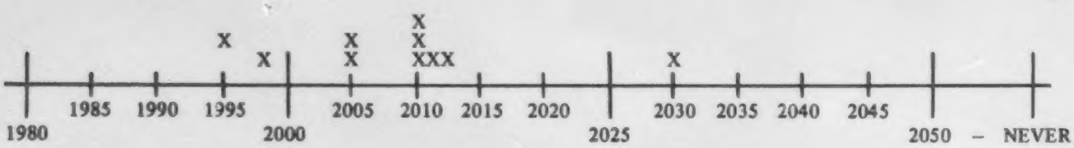
Suppose you wanted to know when a cure for a particular disease will be discovered. If you wished to question many doctors from many research laboratories, you would probably benefit from using a Delphi method.

Recall that the Delphi is a way of collecting independent opinions from a group of experts in such a way that everyone can consider all the important facts. The Delphi is something like a poll and something like a meeting.

A Delphi is conducted in a series of rounds. Here is how a Delphi might work for the question:

> *When will there be a permanent space settlement in orbit around the earth?*

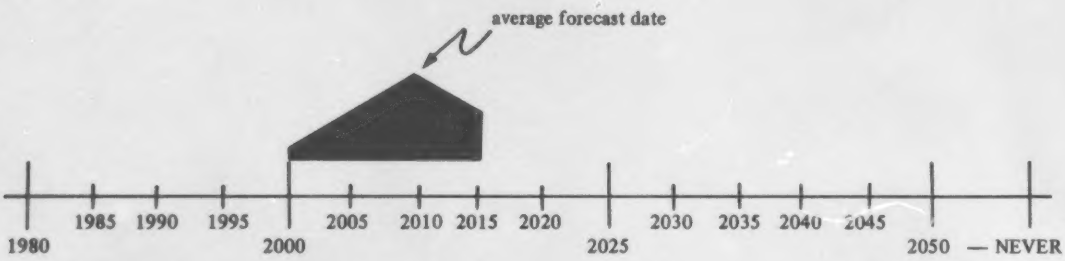
Round 1: Everyone is sent a questionnaire. On the questionnaire, each expert states the year that he or she believes a permanent space settlement will be in place. Here's what ten experts might write.



Round 2: All the experts then get to see how their forecast compares to the forecasts of the others. The experts are asked to revise their forecasts if they wish and to explain why they wrote what they wrote.

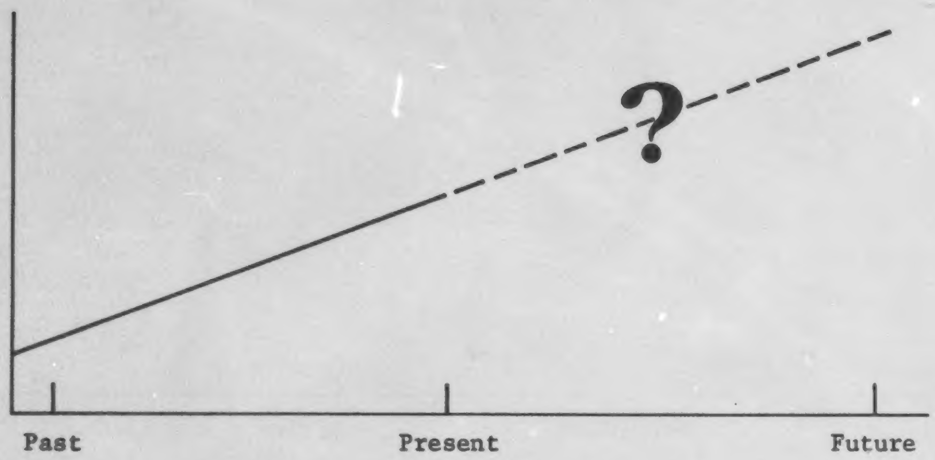
Round 3: All experts then receive a summary of the results of Round 2 and are asked to restate their opinions on the basis of others' opinions and reasons.

The final results of the Delphi show an average forecast date for each development.



Lesson 11

TRENDS



A trend is a pattern of past events. Information is collected and recorded on a timetable. If the information can be converted to numbers, it can be shown on a graph like the one above.

Suppose you wanted to compare what the average factory worker made per hour in 1975 to what workers made in 1950. You could make a table (left) or show the trend as a graph (right).

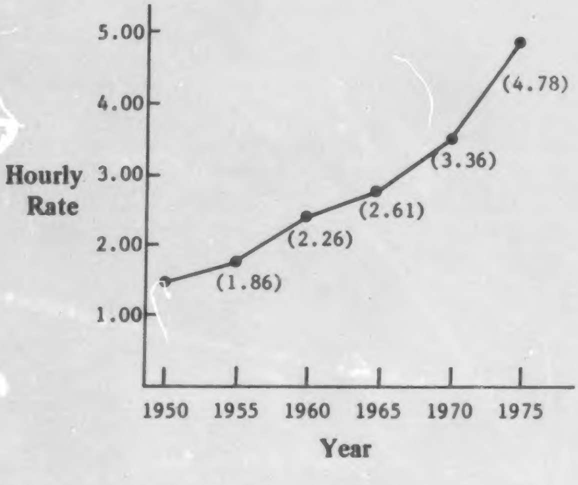
TABLE

Hourly Earnings in Manufacturing Industries (2)

Year	Hourly Rate
1950	$ 1.44
1955	$ 1.86
1960	$ 2.26
1965	$ 2.61
1970	$ 3.36
1975	$ 4.78

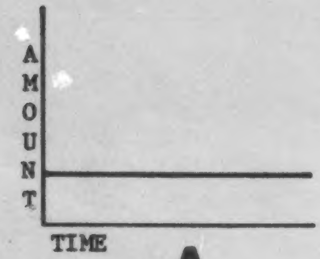
GRAPH

Increase in Hourly Rate for Manufacturing Industries 1950-75 (3)

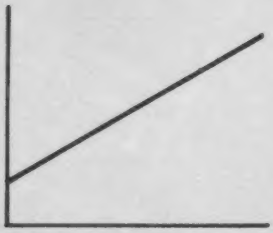


70

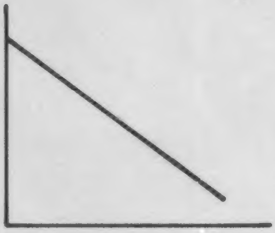
Recall that trends are patterns of past events. The "pattern" refers to the shape or the slope of the line. Trends can take on a variety of patterns, as shown below.



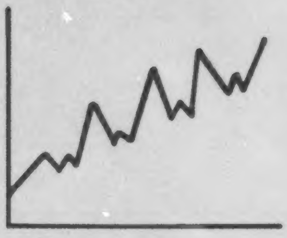
A



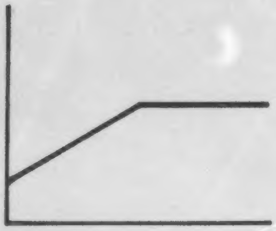
B



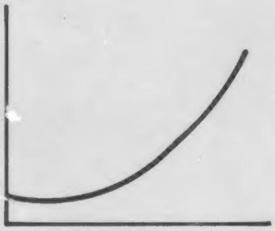
C



D



E



F

Suppose that each of these trends represents a comparison of hourly wages over the past 25 years.

DIRECTIONS:

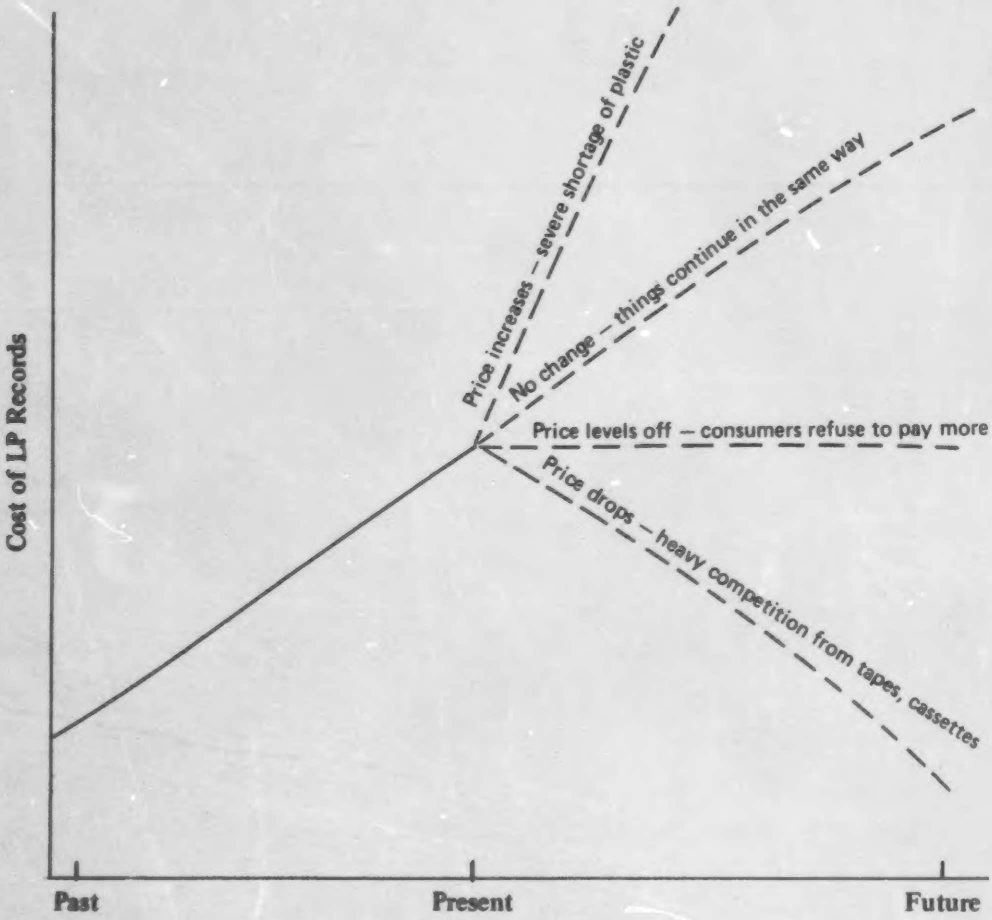
Answer the following questions in your notebook under the heading *TRENDS*.

1. Which trend shows a steady decrease in the hourly wage?
2. Which trend shows an increase followed by a leveling off?
3. Of trends B and F, which shows a steady regular increase over time?
4. Of trends B and F, which shows a slow growth in the beginning followed by rapid growth later on?
5. What does trend A show?
6. What does trend D show? Name one pattern of events that might look like trend D.

TRENDS AND FORECASTS

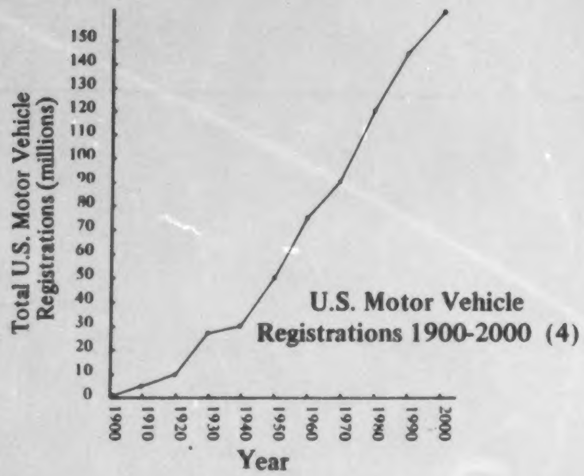
You have learned that a trend is a description of past events. A trend cannot tell you what will happen. If you know that the price of LP records has gone up by $.50 each year for the past five years, you cannot predict the price of LP's two years from now. You cannot be certain. But you can forecast that the price will probably continue to rise. Your best guess for the amount of price increase would be based on a careful study of a variety of factors (the economy, the market for LP's, the cost of plastic, the popularity of cassettes, etc.).

Futurists make forecasts from trends by taking into account the shape of the trend line, anticipated developments in related areas, and other forecasted changes that might affect a trend. Often futurists make a number of forecasts based on a single trend. Below is an example.



COMPARING FORECASTS

Consider these forecasts about the future of private automobiles in the U.S.

	FORECAST	SOURCE AND DATE
A.	Private cars will never be totally banned.	Smil Delphi, 1973
B.	A new car (not gasoline-powered) will be in common use by 1985.	Smil Delphi, 1973
C.	By the year 2000 the U.S. will have 30,000 miles of highways with automated lanes.	A. J. Goldenthal, transportation economist, 1970
D.	By 1978 half the cars in the U.S. will be electric-powered.	Stewart Udall, U.S. Senator, 1968
E.	Cars will make less noise.	Otto Preminger, film director, 1976
F.		U.S. Bureau of Roads, Department of Commerce, 1967.

U.S. Motor Vehicle Registrations 1900-2000 (4)

DIRECTIONS:

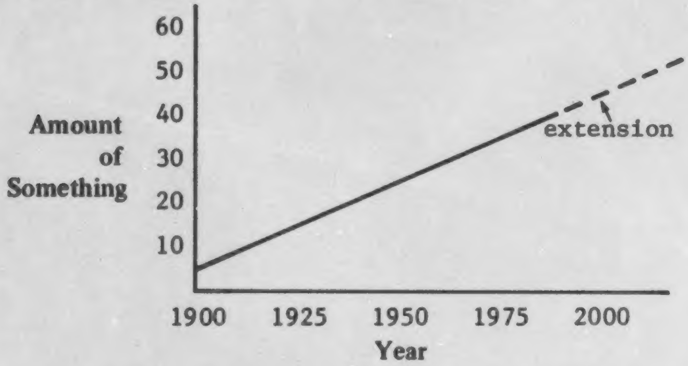
In your notebook write the heading *COMPARING FORECASTS*. Answer the questions below. (Refer to page 63 if you need help.)

1. Using the criterion of RECENCY, which forecast is least trustworthy?
2. Using the criterion of EXPERTISE, which forecast is least trustworthy?
3. Which forecast is NOT CONSISTENT with known facts? Explain.
4. The graph (F) forecasts that over 150 million motor vehicles will be registered in 1990. How might this forecast change if the price of gasoline doubled? Name at least one other development that could change the forecast.

CREATING FORECASTS FROM TRENDS

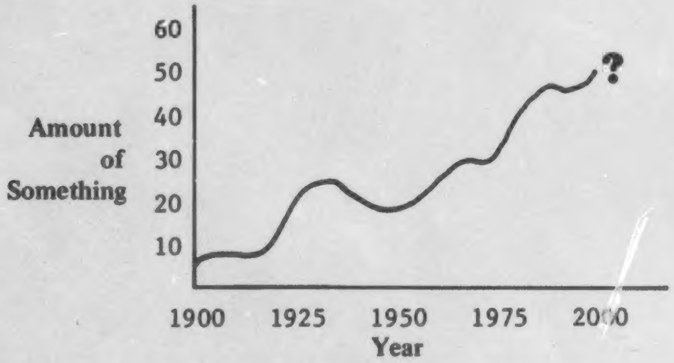
Recall that a graph of a trend gives you a picture of what has occurred in the past. If you wish to forecast what will happen in the future, you may sometimes begin by extending* the line to the date you would like to know about.

Here's what an extension* of a trend looks like:



Thus, if everything continues the way it has been going, you can expect the increase to continue to the year 2000.

But very few trends look like straight lines on a graph.



Where will this line be in the year 2000? How do you extend a trend with a shape like this one?

What you can do is make an estimate, an intelligent guess (a *forecast*):

> *If things continue the way they've been going, by the year 2000 there will be an increase to somewhere between 50 and 60.*

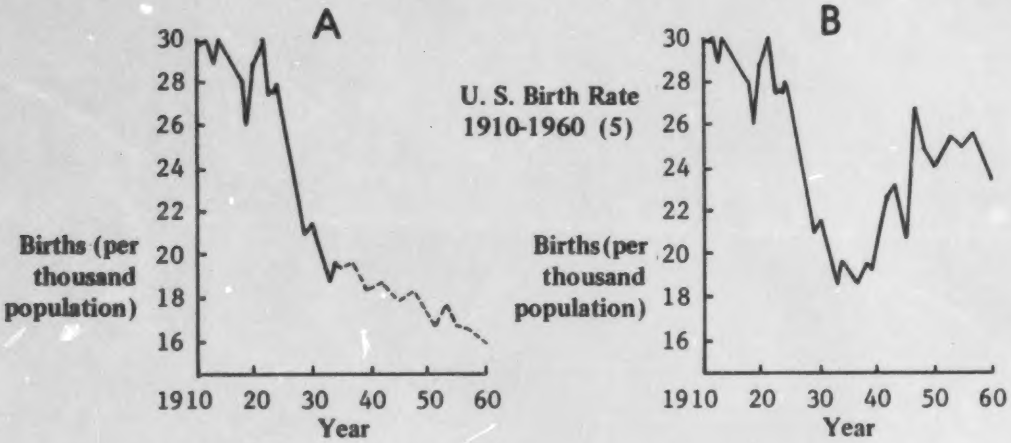
---

*EXTEND — To continue, lengthen, stretch.
EXTENSION — Continuation.

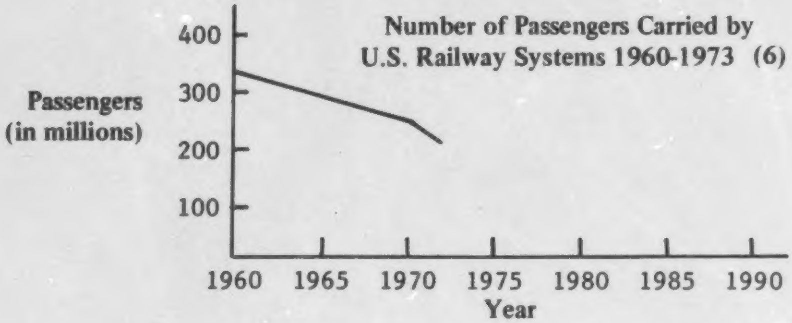
The difficulty with creating forecasts by extending trends is that situations change. "Surprises" happen that change the course of trends.

Suppose it was 1935 and you worked for the Bluebird Baby Buggy Company. Your boss gave you the assignment to make a forecast about birth rates in the U.S. for the next 30 years.

Graph A below shows the forecast you might have made. Graph B shows what actually happened.


U. S. Birth Rate 1910-1960 (5)

The "baby boom" of the mid-40's made forecast A inaccurate. There is another difficulty with extending trends. The graph below shows the number of passengers served by American railway systems for a 13-year period.


Number of Passengers Carried by U.S. Railway Systems 1960-1973 (6)

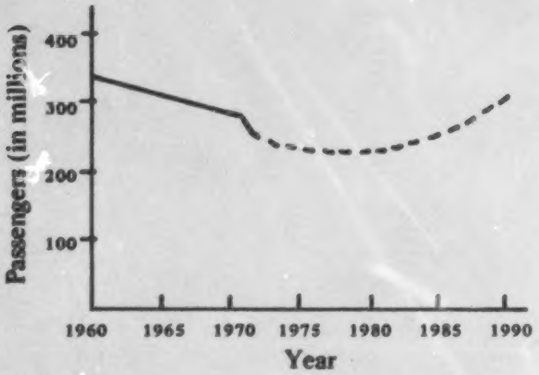
Imagine that you have been asked to forecast the number of passengers likely to travel by rail in the year 1990. Use a ruler to see where the extension would go. Do you think that this is a sensible way to make a forecast in this instance? Why not?

RAILROAD FUTURES

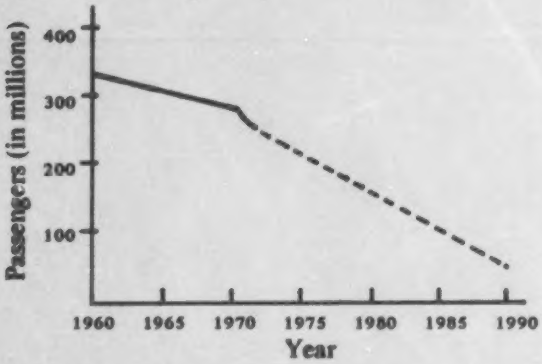
DIRECTIONS:

Under the heading *RAILROAD FUTURES*, write your answers to the following questions in your notebook.

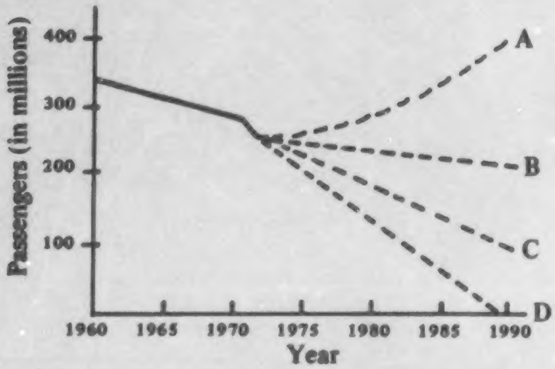
Graph I



Graph II



Graph III



1. Which of the following might explain the forecast shown in Graph I? (Choose one)
   - a. No increase in highway construction. Existing highways jammed.
   - b. Gasoline-powered cars banned in many sections of the country.
   - c. Price of gasoline continues to increase.
   - d. All of the above.

2. Which of the following might explain the forecast shown in Graph II? (Choose one)
   - a. Railroad beds improved. Speed of train travel increases.
   - b. Jumbo jets and SST's banned because of noise pollution.
   - c. Mass production of inexpensive electric cars capable of long distances and high speeds.
   - d. All of the above.

3. Why might forecast D in Graph III be unlikely?

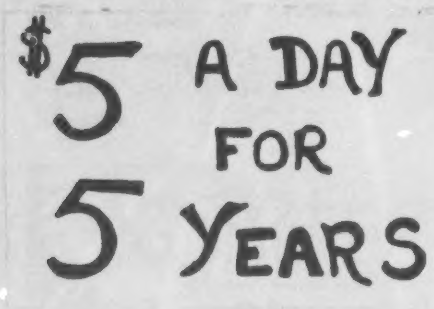
4. Which forecast (A, B, C or D) do you think is most desirable? Why?

5. List some changes that could be made that would make your most desirable forecast more likely to occur.

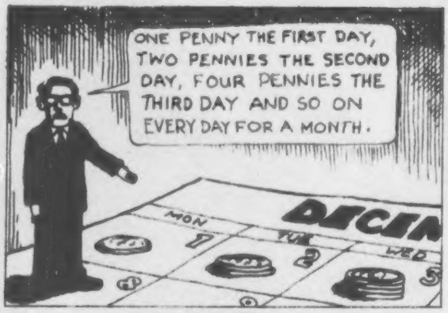
Lesson 11

ACCELERATING TRENDS

Which would you rather have — Prize A or Prize B?


$5 A DAY
FOR
5 YEARS

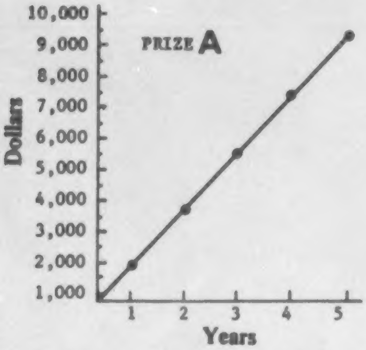
PRIZE A

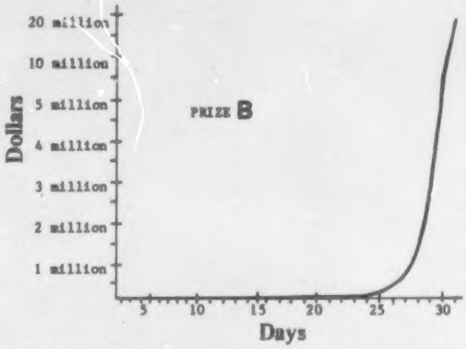

ONE PENNY THE FIRST DAY, TWO PENNIES THE SECOND DAY, FOUR PENNIES THE THIRD DAY AND SO ON EVERY DAY FOR A MONTH.
DECEM
MON
TUE
WED

PRIZE B

For Prize A you would get a fixed amount every day for five years. For Prize B you would start with a penny and then your money would double every day for a month.

Here's what these prizes would look like when graphed.





With Prize B you would have only 64¢ after one week. After week two, you would have $81.92. By the end of week three, things would really start to pick up (accelerate). You would have over $10,000. If you double $10,000 nine more times for the nine remaining days, you'll have over $5 million! If the month has 31 days, you'll have $10,737,418.24.

Accelerating trends start out very slowly. Then they explode as the values get larger and larger.

TRY THIS PROBLEM:

Mr. Smith has a pond. A lily plant in that pond doubles its size every day. In 30 days, the plant will cover the pond.
ON WHAT DAY WILL THE PLANT COVER HALF THE POND?

DIRECTIONS:

Think about it. Then write your answer in your notebook. If you think of another answer later, record this second answer in your notebook without erasing your first answer.

POPULATION

Do you think that population growth is like Prize A or like Prize B from the previous page? The correct answer is Prize B. Population growth is an accelerating trend in most countries of the world. Let's look at some information about the world population.

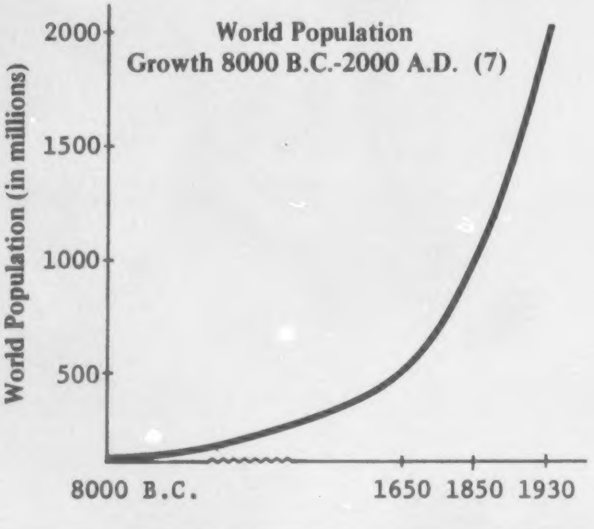
Improvements in medicine and diet have sharply decreased the number of children that die in infancy and have lengthened life expectancy (by about 25 years since 1900 in the U.S.). The result is more people having more children and living for a longer period of time.

Here is a simplified table showing the population trend between 8000 BC and 1976.

Date	Estimated World Population	Growth
8000 BC	5 million	
1650 AD	500 million	
1850 AD	1,000 million (one billion)	Population doubled in 200 years
1930 AD	2,000 million (two billion)	Population doubled in 80 years
1976 AD	4,000 million (four billion)	Population doubled again in 46 years

Can you see that the rate at which the population grows has been increasing? As growth rate increases, "doubling time" (the time it takes a population to double in size) decreased.

A graph of population increase would look something like the figure on the right.

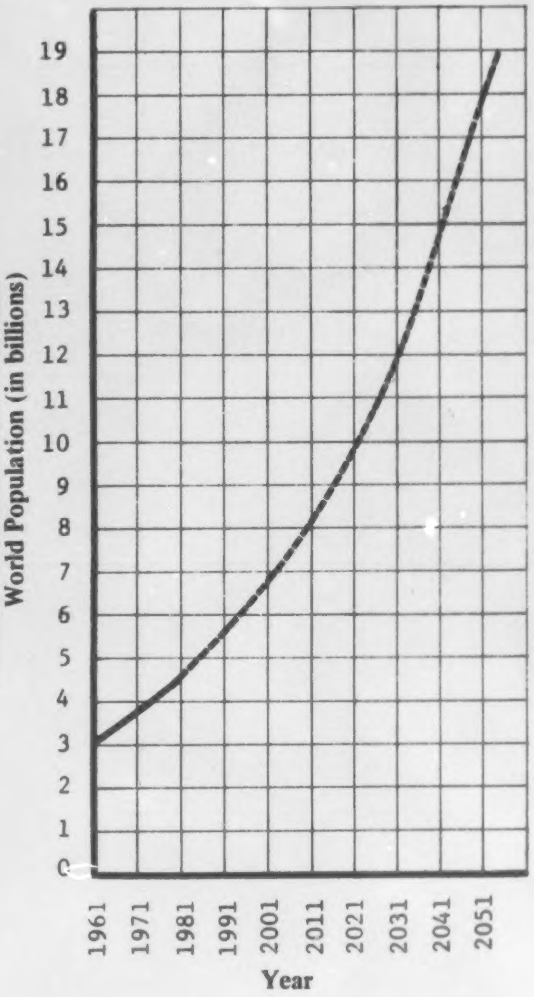

World Population Growth 8000 B.C.-2000 A.D. (7)

Lesson 12

Here are a table and a graph that extend the trend for population growth into the future.

World Population
1961-2051 (8)

Year	Population (in billions)
1961	3.1
1971	3.7
1981	4.6
1991	5.6
2001	6.8
2011	?
2021	?
2031	?
2041	?
2051	?



DIRECTIONS:

Answer the following questions in your notebook under the heading *POPULATION FORECAST*.

1. Forecast the world's population for the years 2011, 2021, 2031, 2041, and 2051 by reading off the graph.
2. How long will it take the 1961 world population to double?
3. How long will it take to double again?

FOOD AND PEOPLE

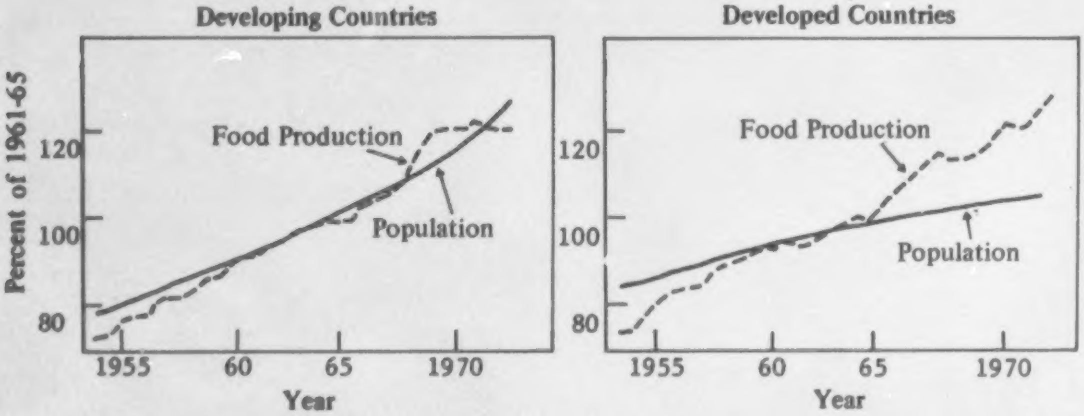
> "World population grows some 2½% yearly. This seemingly small figure means that the population is doubling every 33 years. If this increase continues, a whole new world of people will be added to the world in the next generation, and food production will have to be doubled to provide for an entire 'second world.'"
>
> Graham T. T. Molitor, General Mills, Inc.
> in *The Futurist*, August, 1974.

PART ONE: THE PROBLEM

It was just a few years ago that experts were forecasting that an energy crisis would hit in the 1970's. Few people paid much attention. Schools and industries continued to switch from coal to natural gas heat. People continued to buy "gas-guzzling" automobiles. They thought that the problem would somehow be taken care of. They were wrong.

According to some experts, the energy problem is just a minor annoyance compared to the food crisis. What is the food crisis? Look at the graphs below.

Food Production and Population 1955-1975 (9)



The graphs show that food production in developed countries (European and North American countries, for example) has kept ahead of population growth so far. However, in the developing countries which include most of South America, Africa and Asia, food production has recently begun to lose the race with population growth. *One out of every three people in the world faces hunger and starvation on a daily basis*. Will the developed countries be able to supply the developing countries with food? Will technology be able to provide answers? Will the problem affect you? Look over the information and forecasts that follow and judge for yourself.

What are the major reasons for the food crisis?

1. Population growth. On a worldwide scale, population growth is still the major reason why the demand for food continues to increase. Approximately 73 million people were added to the world's population in 1977 and the size of this increase grows larger each year.

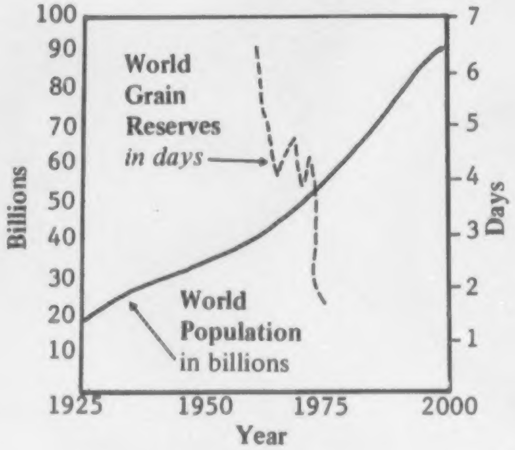
The rate of population increase is not the same for each country. It will take about 140 years for the population of Great Britain to double in size, while India's population is expected to double in just 27 years. You might expect population to increase the most in places where there is an abundant supply of food and a high standard of living. But, more often than not, just the opposite is true. Population growth is highest in those areas where food is most scarce (for example, in India, Pakistan, Latin America, and Southeast Asia).

2. Increased consumption of food. As income rises, people spend more on food and demand richer diets. Since World War II, beef consumption in the U.S. has risen from 55 pounds per person in 1940 to 116 pounds per person by 1972. The average North American consumes five times as much food as the average person in India. The problem with all of this consumption, especially beef consumption, is that it takes eight to ten pounds of grain to put one pound of meat on a steer. The result is a reduction in grain reserves in the developed countries and serious shortages in those developing countries that depend on imports to fight starvation

- In 1972 there was enough grain held in storage in the world to feed the entire world's population for 66 days.

  By 1974 this emergency supply dropped to a level that would feed the world's population for only 26 days.

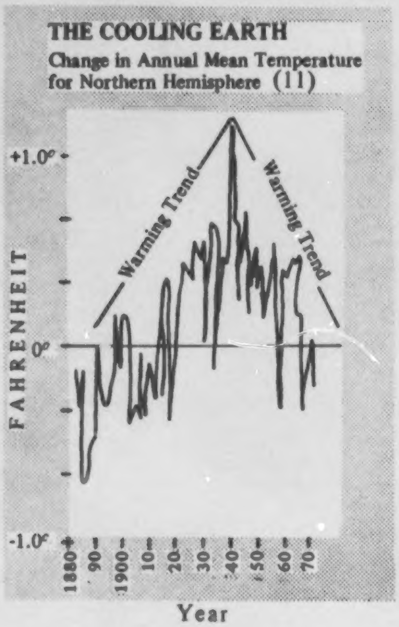
World Population and Grain Reserves 1925-2000 (10)



3. **Increased consumption of water resources.**

- It takes 120 gallons of water to produce one hen's egg.
- A pound of beef requires 3500 gallons of water.

The U.S. Food and Agriculture Organization estimates that global demand for water will expand 240% by the end of the century.

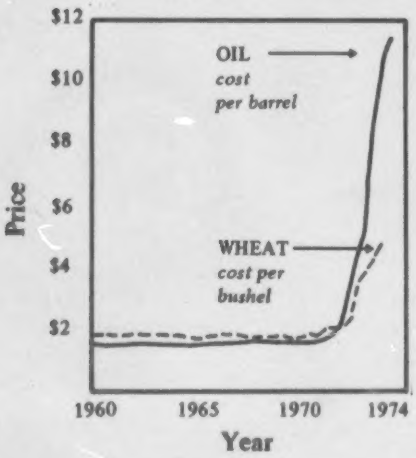


In recent years, severe droughts (dry spells) have hit huge areas of Africa and Asia. Weather experts say that North America, and especially the Midwest, is due for a serious dry period. In the last few years alone, many farmers have been forced to abandon farmland for lack of water.

The reduction in rainfall coupled with colder winters and shorter growing seasons has been linked to a cooling trend that some scientists are calling a "little ice age."

4. **The energy crisis.** Increases in oil prices over the past several years have driven up the cost of planting, harvesting and transporting grain.

World Oil and Wheat Prices 1960-1974 (12)



Enormous amounts of oil are needed to operate farm machinery, run irrigation pumps and produce fertilizer. Food experts estimate that an equivalent of 80 gallons of fuel is used to produce a single acre of corn.

As the price of oil rises, developing countries must cut back on the amount of oil they import and the amount of fertilizer they can produce.

THE CROSS-IMPACT MATRIX

You probably realize from what you've just read that the four causes that were discussed have some effect on one another. How do changes in the weather affect the energy crisis? How do increases in population in one area of the world affect food consumption in another?

A cross-impact matrix* can be used to answer these questions and to make forecasts about possible future consequences. The cross-impact matrix, like the Delphi and the scenario, is a technique for making forecasts about the future. Like a checkerboard it is a way of forcing things together to come up with something new.

		Population	Food	Weather	Energy
Population	Worldwide population increase, especially in developing countries	▨	a	Less food, greater demand on farmland	More demand
Food Consumption	People demand more food, especially in developed countries	Less food available for export; increased hunger	▨	Higher prices	b
Weather	Less rainfall — colder winters	Increased need for disaster relief	Developing countries look for other food sources	▨	More demand for water and heating fuel
Energy Crisis	Less fuel — Higher prices	Prices go even higher; some cannot afford to pay	Prices go higher; exports stop	Less energy available for hard winters and drought relief	▨

DIRECTIONS:

1. **In your notebook, put the heading *CROSS-IMPACT MATRIX* on a sheet of paper.**
2. **Fill in boxes "a" and "b" above by answering these questions:**
    - a. If the population continues to increase in developing countries, how might that influence the increase in demand for food in developed countries?
    - b. As people continue to eat more food, especially meat, how might this trend affect the energy crisis?

---

*IMPACT — A force or an effect, as in a collision.
MATRIX — A square or grid.

FOOD AND PEOPLE

PART TWO: WHAT CAN BE DONE?

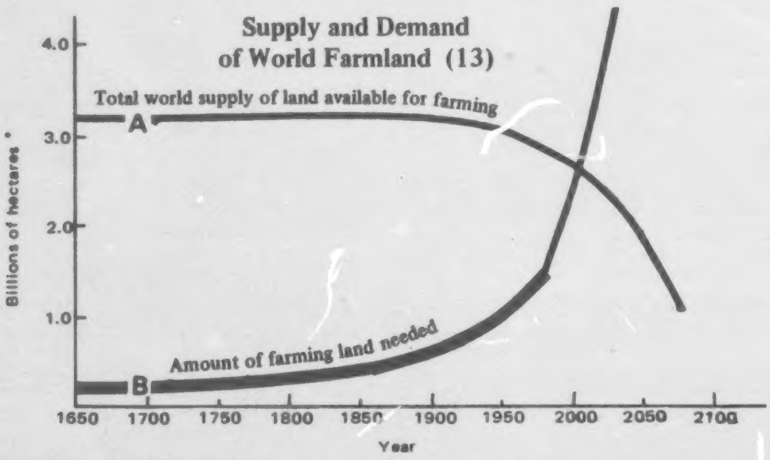
How can we expand food production? How can we keep up with the demand for food? How can we avoid hunger and starvation in the world?

Let's look at three traditional solutions and four newer solutions to the food crisis.

TRADITIONAL SOLUTIONS

1. **Produce more food by finding new farmland.** In the past, the demand for more food often resulted in the search for new farmland. The potato famine in Ireland in the 19th century convinced many farmers to come to America in search of farmland.

But, at present, almost all of the world's farmland is already being farmed.



* A hectare is 2.47 acres.

As can be seen on the graph above, the amount of land available for farming has actually dropped since 1900. More and more farmland is being converted into housing, industrial and recreational sites at a time when the need for new farmland is increasing at an accelerating rate. Other parts of the world are losing enormous amounts of crop land each year to soil erosion.

- The Sahara Desert has begun to move southward at a rate of 30 miles a year due to overgrazing and deforestation (the removal of trees without replacement).

Lesson 13

2. Create new farmland through irrigation. In some areas of the world, land that ordinarily could not support crops can be turned into farmland through irrigation. To do this, a source of clean fresh water is required. Many irrigation systems require a source of power as well. Others demand that a dam be constructed. It has been estimated that in 30 to 50 years, one billion acres of land throughout the world could be brought into production through irrigation and fertilization. The cost would be $500 billion.

3. Increase the productivity of the land – the "Green Revolution." Instead of looking for new land, why can't we get more food from the land we have? The "Green Revolution" is an effort by agriculturalists to increase production through the use of modern scientific growing techniques, better machinery, fertilizers and pesticides. Of the approximately 350 million families presently engaged in farming, more than 70% possess as their one and only tool either a hoe or a wooden plow. Mechanization, fertilizer and "wonder seeds" can dramatically increase the quality and quantity of harvests. New lighting techniques have been developed that increase plant growth rates by 50%. New chemicals have been produced that act as "ripening regulators" to permit harvesting up to two weeks earlier than usual.

However, modern fertilizers are produced from petroleum, modern farm machinery needs fuel, and the development of new seeds and farming methods requires government support.

- Prices for fertilizer rose from $75 a ton in 1972 to more than $400 a ton four years later. These price increases put fertilizer almost out of the reach of developing countries.

NEW SOLUTIONS

With a lack of new farmland and the high cost of irrigation and modernization of agricultural methods, how else can we increase the amount of food needed to feed the world's population?

4. Improve methods of storing and distributing food. At least one quarter of the world's food disappears between the field and the table. India, for example, loses approximately 20% of its imported grain to "rats and rot." Many developing countries do not have adequate warehouses or transportation systems. Food reaches larger port cities but sometimes does not get to inland areas where it is needed most.

Storage usually means expensive silos and grain elevators. Improving distribution usually means improving the transportation system or purchasing trucks and railway equipment. Most developing countries do not have the money to pay for or take care of this equipment.

5. Farm the sea. The sea has long been looked on as a solution to the food crisis. It was thought that we would never use up the supply of fish in the world's oceans. Recently, we have been forced to recognize that the supply of fish is limited. From 1950 to 1970, the world fish catch more than tripled, from 21 to 70 million tons. But, since that time, the fish catch has been declining more than a million tons a year. Some fish are being caught faster than they can reproduce themselves. A number of species of whales face extinction.

Aquaculture (fresh water farming) and mariculture (salt water farming) are possibilities. In Scotland, some fish are brought to marketable size in half the time by being raised in thermally polluted (hot) waters. The Russians raise carp in the hot water waste from nuclear power plants. So far, money and a lack of "farming" space have been the main obstacles in those industries.

Hydroponic gardening is a method of gardening that does not require soil. Plants are grown in water that is specially treated with minerals. A family of four can be fed with only 200 square feet of space by using hydroponic gardening and a greenhouse (five times less space than is required for regular farming).

6. Population control. More than $250 million dollars is spent each year to spread the message of family planning. Most experts believe that it will take at least four times that amount to do the job effectively. One of the difficulties with trying to keep down the population is that in many developing countries a couple will have many children in order to supply the labor needed to help with the farming.

7. Eat less. The U.S., with six percent of the world's population, consumes 30 percent of the world's food supplies of animal origin. Harvard nutritionist John Mayer estimates that if Americans would eat 10% less meat they would release enough grain to feed 60 million people.

Attempts to reduce consumption or change eating habits in developed countries has not been successful so far. People do not see the food crisis as important until their grocery store runs out of something they like.

WORLD FOOD FORECASTS

Read the following five forecasts on this and the next page carefully. Be prepared to discuss what they mean at your next class meeting.

A "Perhaps in ten years, millions of people in the poor countries are going to starve to death before our very eyes...We shall see them doing so upon our television sets. How soon? How many deaths? Can they be prevented? Can they be minimized? These are the most important questions in the world today."

C. P. Snow, British author and statesman, 1969 in *Newsweek,* April, 1974.

B "We have the means, we have the capacity to eliminate hunger from the face of the earth in our lifetime. We need only the will."

John F. Kennedy, from a speech delivered to the first World Food Congress, 1963.

C "The race between population growth and food production has already been lost. Before 1985, the world will undergo vast famines — hundreds of millions of people are going to starve to death...unless plague, thermonuclear war, or some other agent kills them first."

Paul R. Ehrlich, biologist, in *National Geographic,* July, 1975.

D "The world has the physical capacity to feed itself...Less than half the arable (farmable) land on the planet is being cultivated now. And the technology, fertilizer and other raw materials will be available if people and their governments are willing to pay the price."

William R. Gassen, economist,
U.S. Department of Agriculture,
in *U.S. News and World Report,*
March 24, 1975.

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E "Confining ourselves to practical farming methods already used by the good farmers in different parts of the world, the world's cultivable and pasturable lands could feed something like ten times the world's population, not at subsistence levels, but in an American style of diet."

Colin Clark, former director of
Oxford University Agricultural
Economics Institute,
in *U.S. News and World Report*,
January 28, 1974.

DIRECTIONS:

1. Which quotations are forecasts? Which are opinions?
2. Based on what you've read, which quotations do you agree with? Which do you disagree with?
3. Make up a forecast on your own. Make a forecast for 20 years from the present. In your forecast, state how the world will deal with the food crisis. Describe how your community and your life style will be affected by the food crisis (if at all).

CROSS-IMPACT MATRIX

A cross-impact matrix can be used to look for positive consequences, for negative consequences or for new ideas.

	more people	more highways
shorter work week	more time to meet more people	increased freedom
more job changes	more service jobs	moving becomes easier

+

	more people	more highways
shorter work week	more boredom	more pollution
more job changes	more competition for jobs	less community spirit

−

	more people	more highways
shorter work week	people could live in two places	three-day vacation passes
more job changes	need for career counselors	mobile offices

Can you see that it is possible to look for different kinds of impacts with the same matrix?

PERSONAL IMPACT MATRIX

Here is another type of matrix. This matrix can be used to look for the effects that possible developments might have on your career.

	POSSIBLE DEVELOPMENTS		MY CONCERNS		
			I My Future	II My Community	III Possible Jobs
A	Self-Sufficient Homes	All homes built after 1990 must provide their own energy for heating, cooling, lighting, etc.	?	Less fossil fuels so less fires.	Energy counseling and housing contracting will be expanding fields.
B	Educational Pension	All employers after 1990 must provide one month of educational credit for each six months of employment.	I could quit school then go back when I know what I want to do.	Increased use of school facilities in evenings by all age groups.	?
C	Noise Pollution Laws	After 1990 it will be against the law to make noise. This law will be strictly enforced.	?	?	?

Suppose you wanted to know what effect the three possible developments (A, B and C) might have on life in the 1990's. To begin to answer this question, you could construct a matrix like the one above. To fill in this matrix you would ask yourself:

If this development were to happen, what might that mean

for my future?
for my community?
for possible jobs?

When an idea occurs to you, you would fill in the appropriate square.* These ideas can be called *IMPACT STATEMENTS*. Your impact statements could describe desirable or undesirable consequences.

Lesson 13

FOOD CRISIS SOLUTIONS

DIRECTIONS:

Seven "solutions" to the food crisis were given on pages 81 to 83. For each solution, at least one fact or reason was given for why that solution might not work. Choose the two solutions you like best. Rewrite the solutions as specific challenge statements.

Here's how to do it:

1. **In your notebook, list two of the seven solutions.**
2. **For each solution select one fact that represents a complaint or an obstacle to the solution – a reason why that solution might not work. Write that obstacle beneath your solution.**
3. **Make a challenge out of it. State the problem as a challenge by including the obstacle in your statement. (See the example below.)**
4. **List solutions for your challenge statement.**

Example:

1. Solution: Find new farmland.

2. Obstacle: We can't find new farmland. It's already being used for recreation, industry and housing.

3. Challenge: How can we use fertile recreational, industrial and residential land to grow crops?

4. Solutions: Unemployed people could plant crops in state and national forests.
   We could harvest the grassy areas alongside turnpikes.
   Workers could farm the land around industrial plants on their lunch hours.
   Buildings could be built on stilts.
   We could live and work above farmland.

FOOD AND PEOPLE: ADDITIONAL COMPLAINTS

1. A large portion of the world's farmland is currently being used to grow crops that have little or no nutritional value, for example, tobacco and coffee.

2. Farming is most practical on land that is flat and free of rocks. Large amounts of flat, fertile land are currently being used for grazing animals, especially cattle.

3. India has large amounts of land that could be made farmable through irrigation. Unfortunately, India lacks the resources to buy the expensive earth moving equipment that would make it possible to dig irrigation ditches.

4. Of the 143 million tons of grain harvested in the U.S. in 1974, 108.3 million tons, or more than 75% of the total harvest, went to feed American cattle.

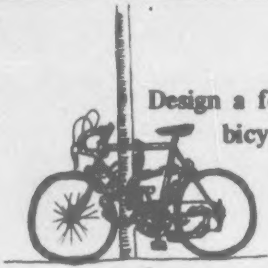
5. In an attempt to respond to the food shortage, India, Pakistan and Bangladesh cleared large areas in the Himalayan foothills to make room for more crops. But without the trees and scrub brush which act as giant sponges to sop up and hold rainfall, rainwater rapidly ran off the slopes, destroying crops and causing floods.

6. Unusually wet weather during the planting season can prevent modern farmers from planting crops. Tractors cannot be used because they get stuck in the muddy soil.

7. Synthetic foods have been developed. These foods, made from chemicals, are rich in protein and other nutriments but are usually unacceptable to the taste. Synthetic foods have not caught on even in countries where natural food is scarce.

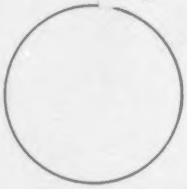
Think Of Ten Uses For:

A. Used Razor Blades
B. Old Railroad Cars
C. Old Refrigerators



Design a foolproof bicycle lock.

Design a cheap anti-theft alarm for bikes.

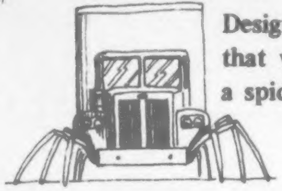


Using just three lines, cut this circle into eight parts.

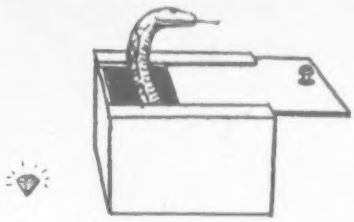
How could you use wave power to produce electricity?

Design a train that never stops

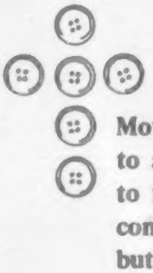
Design a supermarket without lines.



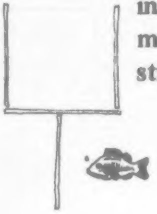
Design a truck that works like a spider.



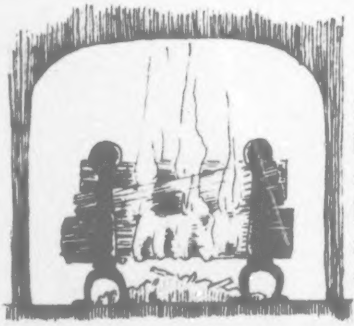
Suppose the diamond was inside the box with the poisonous snake. How could you get the diamond out of the box without using any tool or weapon?



Move one button to another position to form two rows containing four buttons each.

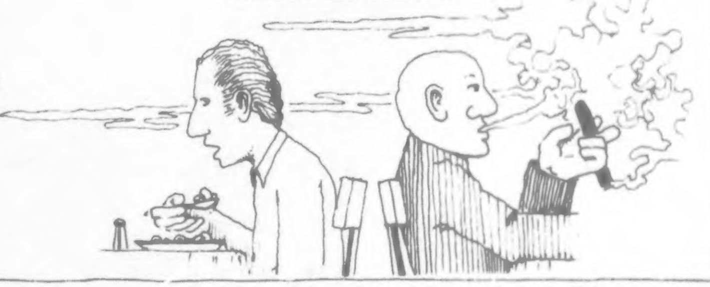


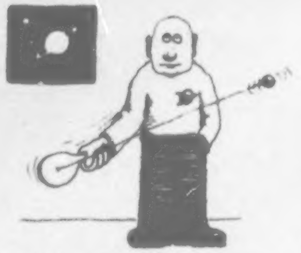
Capture the fish inside the 'U' by moving just two sticks.



Design a house that could be heated by a single fireplace.

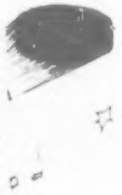
Design a restaurant where smokers and non-smokers can eat without discomfort.





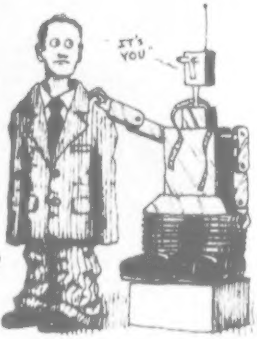
Design recreation activities for space station dwellers.

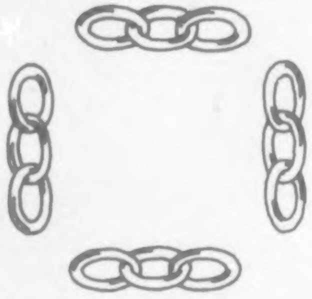
If we had a cashless society, would children still get an allowance?



Design a
WHEELCHAI
HOCKEY
MATCH

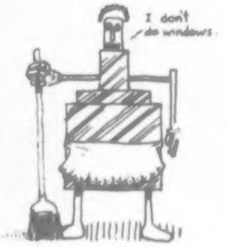
What might an automated clothing store look like?
What would an automated tailor look like?





A jeweler charges one dollar to break a link and one dollar to melt a link back together. In order to join the four corners into a necklace, the jeweler's bill was eight dollars.

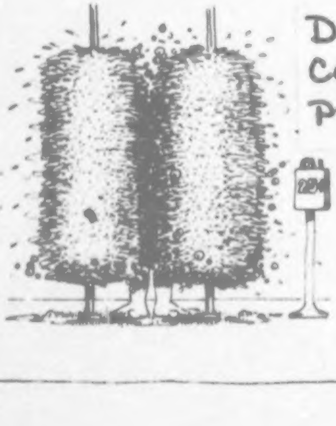
How could the jeweler have done the job for six dollars?



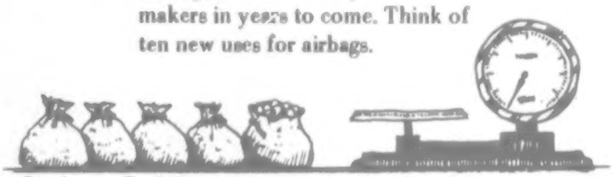
Draw a robot that would be capable of doing most household chores. How would it work? What would it be unable to do?

Illustrate a cheap method for lighting a city at night.

Airbags will be used by some automobile makers in years to come. Think of ten new uses for airbags.



Design a
Coin operated
People washer



You have five bags. Each bag contains 20 coins. One bag contains gold coins. The others are fake. The only way you can tell a gold coin from a fake coin is by weight [gold coins weigh 31 grams, fake coins weigh 30 grams].

How could you find the bag of gold coins by using the scale only one time?

MAKING CHANGES

OBJECTIVES – UNIT III

What you should be able to do when you complete each lesson of Unit Three:

Lesson 15
- Know what an ANALOGY is.
- Know what a WISH STATEMENT is.
- Be able to use wish statements to look for analogies.

Lesson 16
- Be able to use the EXPLOSION technique to identify possible analogies.
- Know the three kinds of PERSONAL ANALOGIES: BE THE THING, BE THE ANALOGY and BE THE PROBLEM.
- Be able to act out personal analogies and use this technique to think of ideas for problems.

Lesson 17
- Know what a CLASH STATEMENT is.
- Be able to find KEY WORDS and use them to write clash statements.

Lesson 18
- Know the steps of an ANALOGY EXCURSION.

Lessons 19 and 20
- Be able to use each step of an analogy excursion to solve a problem with your group.

Lesson 15

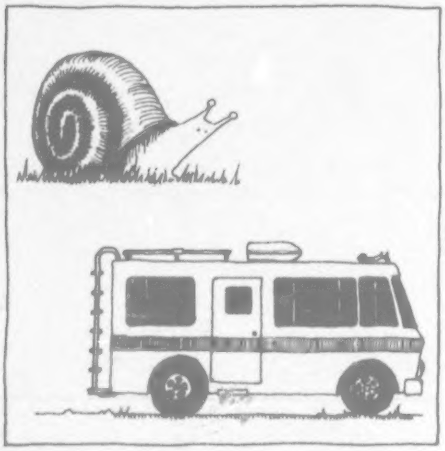
LOOKING FOR ANALOGIES

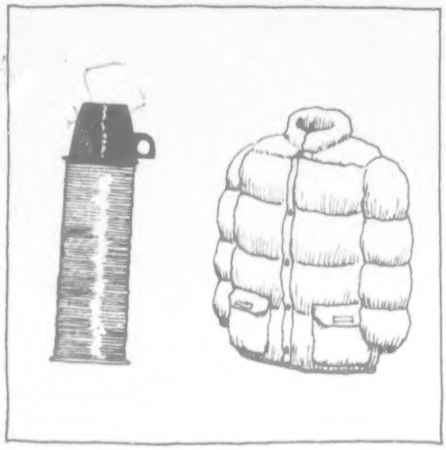
The next few lessons will teach you about one final method for thinking of ideas. The method is called: LOOKING FOR ANALOGIES.

Although you may not be familiar with the word ANALOGY, you probably use analogies every day.

> "Taking that test was like getting a tooth pulled."
>
> "That car climbs hills like a cat."
>
> "That kid is as sly as a fox."

An analogy is a description of a similarity or likeness. It is a statement about how two unlike things are alike.

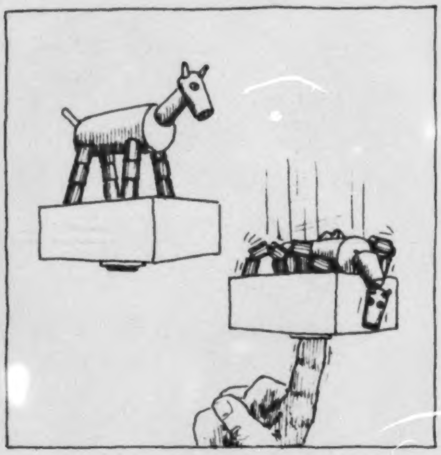


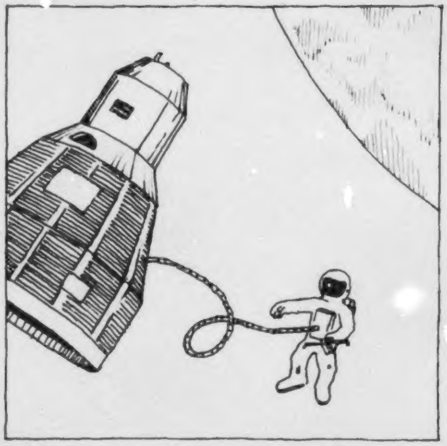


Can you see that the snail and the camper are different and similar at the same time? One is an animal and the other is not, yet both are movable homes. The thermos bottle and the down-filled parka do not look alike yet they work in a similar way to keep things warm.

Lesson 15

USING AN ANALOGY means finding a solution to a problem by looking around for something that will fit your needs.

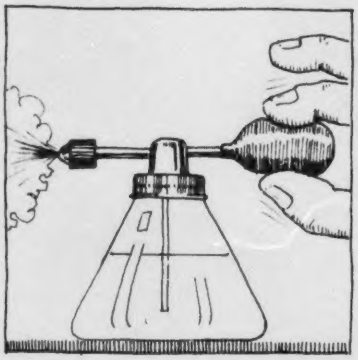


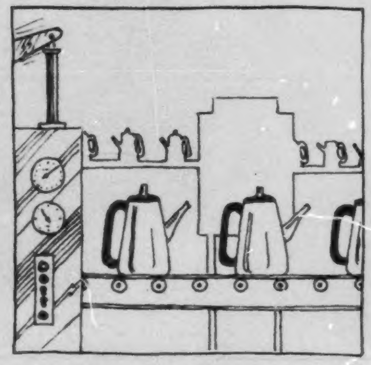


Space scientists could not figure out how to bring astronauts back safely to capsules in space. The astronaut has to float free like a kite on a string until it is time to return to the capsule. At that time, the "line" must be as firm as a pole. The problem sounded impossible to the scientists until one of them noticed a child's toy which was made of string and beads. When there's slack in the string, the toy collapses; but when this slack is released, the toy becomes firm again. Here, in this child's toy, was the solution to their problem — a rope made by stringing a flexible cable through a series of bead-like joints.

Let's look at a few more examples of how analogies can help to solve problems.

Duryea, an early experimenter with "horseless carriages," developed the idea of the automobile carburetor from observing how an atomizer works. He took the idea of an atomizer, which sprays a combination of perfume and air, and built a carburetor to spray a combination of gasoline and air.

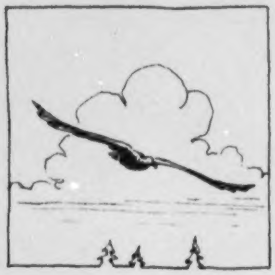


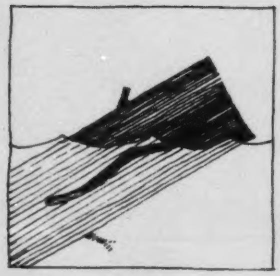


Eli Whitney noticed that many copper engravings could be made from a single copper plate. This observation led him to suggest that machine parts could be made in the same way. The result was the beginning of mass production.

Many inventions have resulted from inventors taking the time to study nature.

The Wright Brothers were not able to keep their gliders balanced in flight until they noticed how buzzards twist their wings. They installed wires in their first airplane which allowed them to twist its wings like a buzzard's.





Sir Mark Brunel watched a ship worm tunnel through a sunken timber. From the action of a ship worm came the idea of building a tunnel under water by pushing one cylinder in front of another and holding back the water by means of air pressure.

Can you see that famous and important inventions can develop from very simple ideas — ideas that anyone can have?

THIS IS HOW I DID IT

DIRECTIONS:

Pretend that you are a famous inventor. For each of your famous inventions, name the animal that gave you your idea and describe how you made your idea work. The first one has been done for you.

Example: The First Pair of Scissors

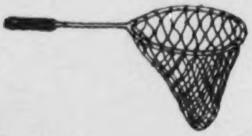
I was swimming near Cape Cod when I spotted a crab. It was pinching a shell.

The crab was actually slicing the shell from above and below at the same time.

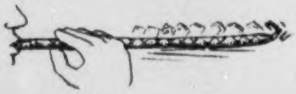
I thought, "Why not join two knife blades together like a crab's claw?"

IN YOUR NOTEBOOK, NAME THE ANIMAL THAT GAVE YOU THE IDEA FOR THE FOLLOWING INVENTIONS AND DESCRIBE HOW YOU MADE THIS IDEA WORK.

1. **The First Fish Net**

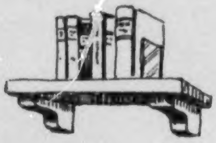


2. **The First Apartment House**
3. **The First Party Toy**



Many of your famous inventions came from studying plants. IN YOUR NOTEBOOK, NAME THE PLANTS THAT GAVE YOU THE FOLLOWING IDEAS.

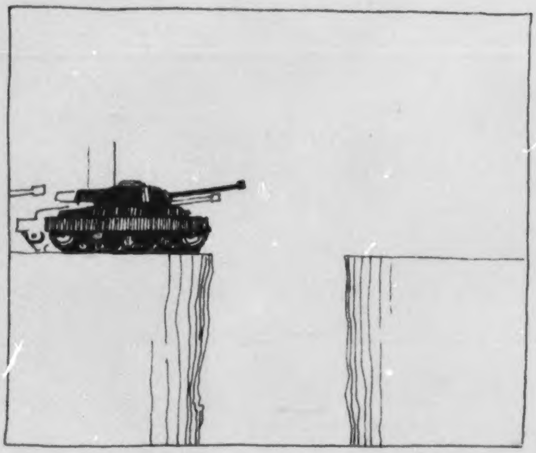
4. **Wall to Wall Carpeting**
5. **Wall Shelves**



6. **Barbed Wire**

Lesson 15

LOOKING FOR SIMILARITIES



The best way to think of analogy ideas is to ask questions. Look at this example:

Suppose you were faced with the problem of how to get heavy tanks across deep ditches. You can't build a bridge every time a tank comes to a ditch. You also must solve the problem in such a way that the tank operators won't have to leave the safety of their tanks.

You might begin by asking yourself some general questions, then brainstorming possible answers:

★ IF I COULD HAVE ANYTHING I WANT, WHAT WOULD I WISH FOR? *What I need is an automatic bridge builder tank; a jumping tank; a flying tank.*

★ WHO ELSE HAS A PROBLEM LIKE THIS ONE? *Skiers, mountain climbers, armies that had to cross moats in ancient times.*

★ WHAT DOES THIS PROBLEM SUGGEST? Next, you might search through your memory to see if you know a way of solving this problem. Here are some specific questions you might ask yourself:

ANIMALS (How do fish, birds, mammals, insects solve this problem?)

- salmon jumping upstream
- ants crossing streams
- birds gliding over ditches
- monkeys swinging from tree to tree

PLANTS (How do plants "move"?)

- seeds flying in the wind
- seeds carried in animal fur

OTHER PLACES/OTHER TIMES (How have humans solved a problem like this one? How did ancient people solve this problem?)

- catapults
- Evel Knievel crossing a canyon
- wires and pulleys, as in moving things from ship to ship
- cranes for moving things from ship to shore
- ramps for moving autos from railroad cars to the ground

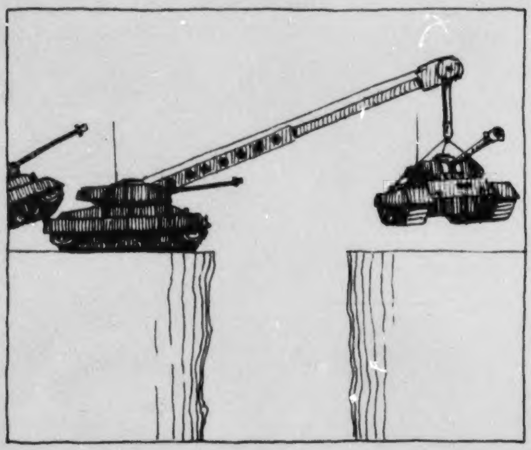
DIRECTIONS:

Do any of these possible analogies suggest a solution to you? If so, go directly to your notebook and draw a possible solution.

Did the analogy ideas on the previous page suggest any solutions to you?

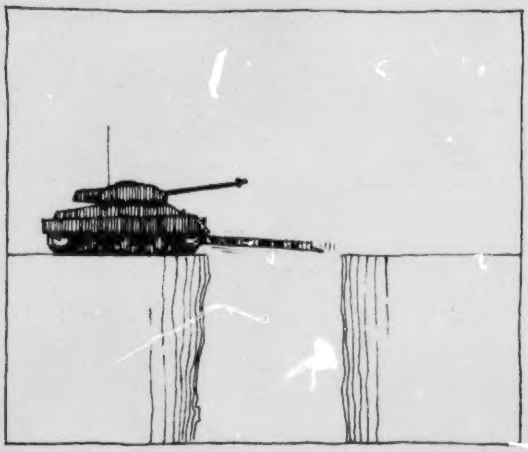
__Analogy:__ *The problem is like unloading cargo ships at a dock.*

__Idea:__ Put a crane attachment on the tanks.



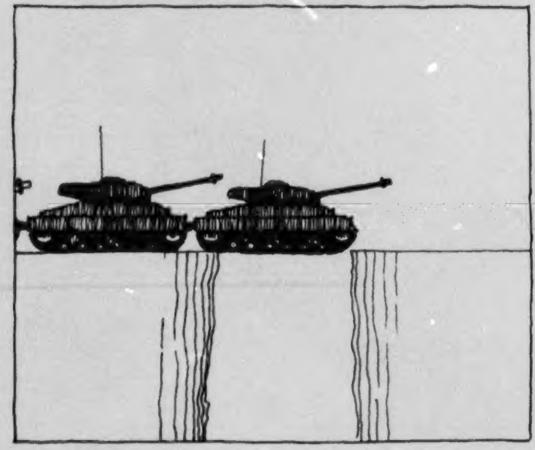
__Analogy:__ *The problem is like getting cars off a train or auto carrier.*

__Idea:__ Equip tanks with retractable ramps.



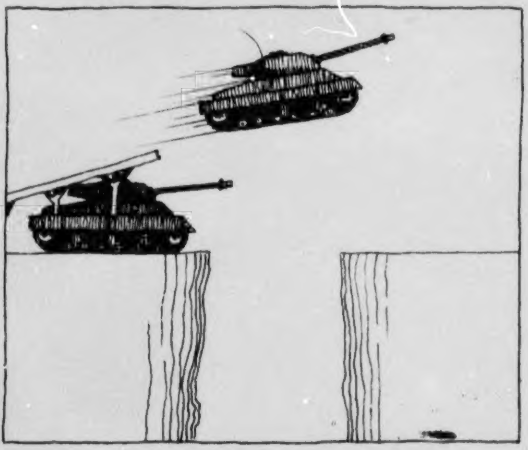
__Analogy:__ *The problem is like insects whose path is blocked by a small stream.*

__Idea:__ Make the tanks "cooperate" like ants crossing a stream. Hook several tanks together.



__Analogy:__ *The problem is like jumping across a canyon on a motorcycle.*

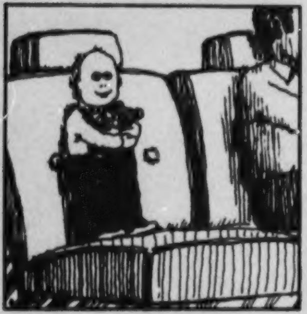
__Idea:__ Have the tanks fly across like Evel Knievel.



Can you see that just as in brainstorming, it is a good idea to think of many wild and imaginative ideas? Sometimes the best solutions are the ones that come from the wildest ideas.

DIRECTIONS:

Try to think of solutions for the following problems by using the questions and suggestions below. Feel free to think of your own analogy ideas. RECORD YOUR IDEAS (OR ILLUSTRATIONS) IN YOUR NOTEBOOK.



PROBLEM: Little children are so light that they are easily thrown off balance and injured in automobiles. Seatbelts aren't satisfactory because they're either too loose or too tight. Special seats work only for very young children. Most children resist the special seats because they don't give any freedom of movement.

GENERAL QUESTIONS:

★ IF I COULD HAVE ANYTHING I WANT, WHAT WOULD I WISH FOR? *Flexible straps, a movable shield, limited freedom.*

★ WHO ELSE HAS A PROBLEM LIKE THIS ONE? *Animals protecting their babies, anyone with something to protect.*

★ WHAT DOES THIS PROBLEM SUGGEST?

ANIMALS: fish, mammals, birds, insects, reptiles, amphibians

- fluid in an egg protecting the embryo
- skeletons on the outside, like an oyster
- octopus tentacles
- an armadillo (hard, flexible skin)

PLANTS: trees, flowers, seeds, grasses, fruits, vegetables

- milkweed pod
- corn husk
- watermelons

OTHER PLACES/OTHER TIMES: ancient people, other cultures, machines, human inventions, geological formations

- hammock
- shock absorber
- boxing glove
- automobile air bag
- egg carton
- water bumper

DIRECTIONS:

1. **In your notebook, describe three analogies that might result in a solution to this problem.**
2. **When you have recorded your ideas for this problem, try the one on page H-21 in your notebook.**

Lesson 15

WISH STATEMENTS

Recall the tank problem from the homework assignment. The first question asked was: IF I COULD HAVE ANYTHING I WANT, WHAT WOULD I WISH FOR?

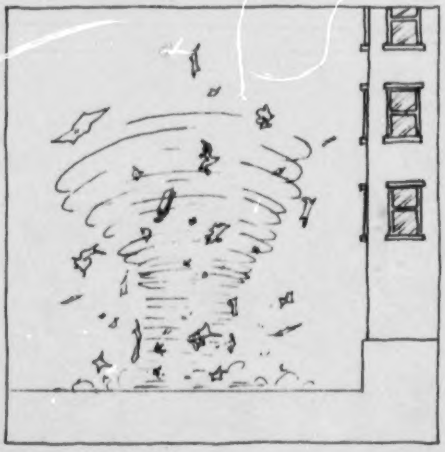
Answers to this question are called *WISH STATEMENTS*. Wish statements help you to understand what the real problem is.

- Wish statements are goal statements.
- Wish statements express the perfect goal.

Look at this example:

PROBLEM: Open areas next to stores and tall buildings are places where junior windstorms and tornados develop. Litter is picked up by the wind and dropped in these open areas, which creates a mess.

QUESTION: IF YOU COULD HAVE ANYTHING YOU WANT, WHAT WOULD YOU WISH FOR?



WISH STATEMENTS:

I WISH the wind would use the litter basket.

I WISH the wind would pick up after itself.

I WISH the wind would decide to go play somewhere else where it would do some good.

Notice that these wish statements are fantasy statements. They are asking for the impossible. The wind can't make decisions. It can't obey. Why talk about magic if you're trying to solve a practical problem?

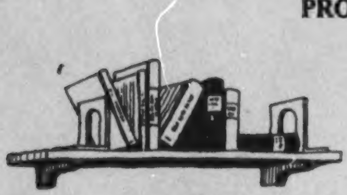
But wait. Before you reject these statements as silly, think about blocking the wind somehow so that it would release litter into a basket. Think about changing the course of the wind so that it would act like a vacuum sweeper. It would sweep the area clean then go into reverse and drop the litter. Think about using the wind to power a windmill that would power a machine that would pick up the litter.

Can you see that silly-sounding wish statements can be turned into practical solutions?

Lesson 15

DIRECTIONS:

See if you can write wish statements for the following problems. Use your notebook.

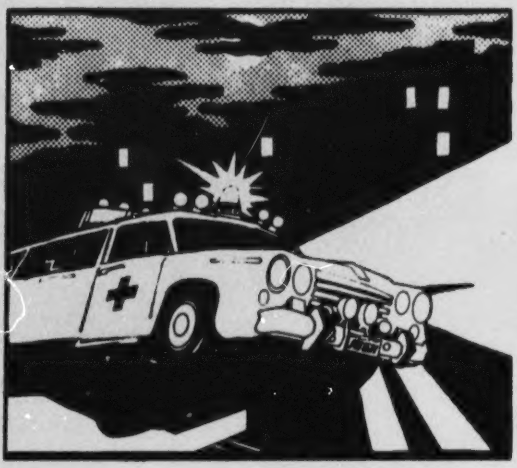


PROBLEM: Bookends just don't work very well. When you remove a book from a shelf, even if you're careful, the other books fall all over themselves. Sometimes the tumbling books cause the bookends to move and all the books end up lying flat.

QUESTION: IF YOU COULD HAVE ANYTHING YOU WANT, WHAT WOULD YOU WISH FOR?

WISH STATEMENTS: ? ? ? ? ? ? ?

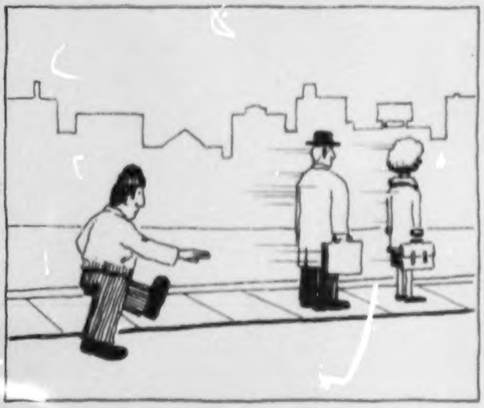
PROBLEM: People who are deaf or who have hearing problems have more difficulties with driving than people who hear well. There are many situations where an accident might have been avoided if the driver could have heard the sound of an oncoming train, a beeping horn, or an ambulance siren.



QUESTION: IF YOU COULD HAVE ANYTHING YOU WANT, WHAT WOULD YOU WISH FOR?

WISH STATEMENTS: ? ? ? ? ? ? ?

USING ANALOGIES



Wish statements often suggest analogies and analogies suggest ideas. See if you can think of solution ideas for the following problem.

PROBLEM: Moving sidewalks have been proposed as a mass transportation alternative in cities, at airports, and at large shopping centers. To be practical, they would have to move rapidly. But how would people get on and off the sidewalk without injury?

DIRECTIONS:

For each of the three wish statements, describe two solution ideas using one or more of the given analogies. USE YOUR NOTEBOOK TO RECORD YOUR IDEAS.

WISH STATEMENT A: *I wish that the sidewalks had hooks or something that would pick people up and put them down gently.*

ANALOGY: *Speeding trains picking up mail bags.*
Launching a jet from an aircraft carrier.
Slowing down a jet that has landed on a carrier.

IDEAS FOR USING THESE ANALOGIES: Example — *Attach rings on springs to the sidewalk and to the off ramps. People could grab the rings and the springs would absorb the shock of getting on and off.*

WISH STATEMENT B: *I wish the sidewalk could speed me up and slow me down gradually to get me on and off.*

ANALOGY: *Deep sea divers wait at different levels to avoid "the bends."*

IDEAS FOR USING THIS ANALOGY: ? ? ? ? ? ? ? ?

WISH STATEMENT C: *I wish that a sidewalk could move very fast and move very slowly at the same time.*

ANALOGY: *Rivers have currents that move at different speeds. If you're in a canoe on a fast-moving river, the way to slow down is to paddle to the outside at a bend in the river. A roller coaster moves very fast and very slowly.*

IDEAS FOR USING THESE ANALOGIES: ? ? ? ? ? ? ?

DIRECTIONS:

In your notebook, write at least one wish statement, one analogy idea, and one solution idea for one of the following problems.

Problem A: How can I get a friend to stop smoking cigarettes?

Problem B: Washing the outside of windows on a high-rise building is a never-ending task. It's dangerous and very expensive.

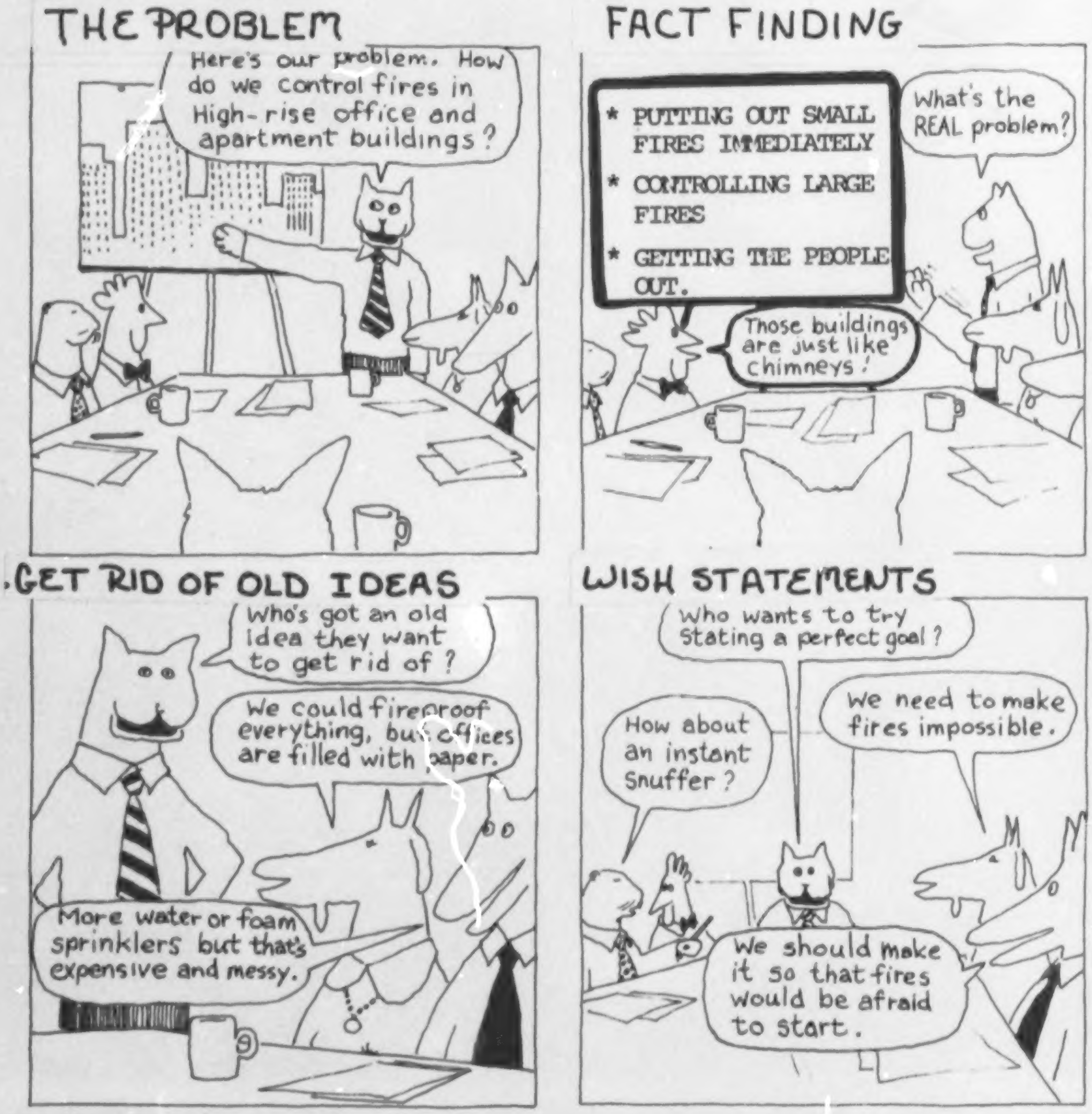
Problem C: Many blind people are satisfied with using seeing-eye dogs. Others wish there were another way of getting around. For those people, using a cane is too slow and too risky, while dogs are too expensive and bothersome.

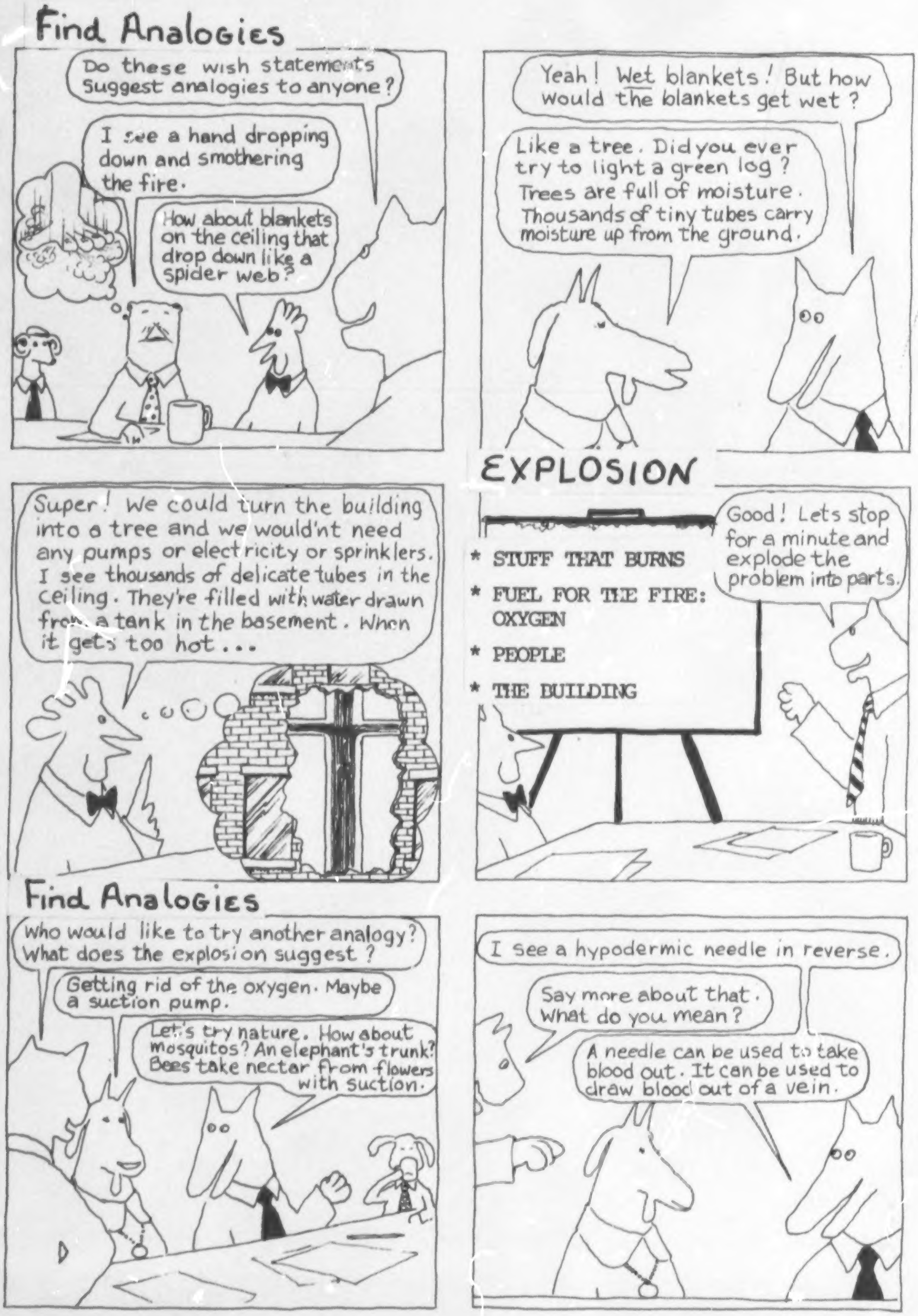
Problem D: Glass buildings and walkways are pleasant for people but not for birds. These all-glass structures are almost transparent to flying birds with the result that they fly into the glass panes at full speed and are often killed or injured.

ANALOGY EXCURSION I

Looking for analogies is often easier when a group of people work together on the same problem. In a group an analogy session works something like an excursion (a sightseeing trip). You begin the excursion by agreeing on a goal, then members have the opportunity to "go away" and use their imagination, to look at different possibilities, to collect ideas and to have a good time.

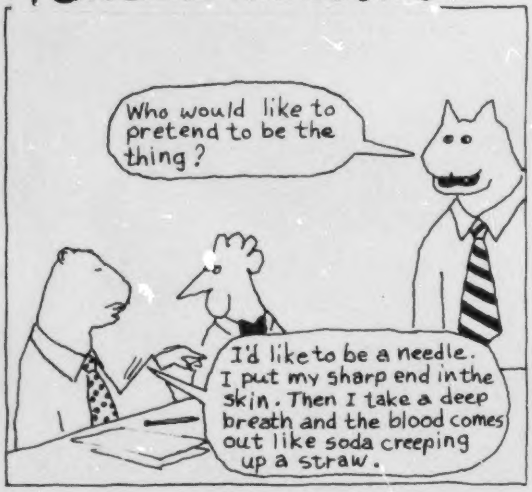
On the next few pages is an example of an analogy excursion:

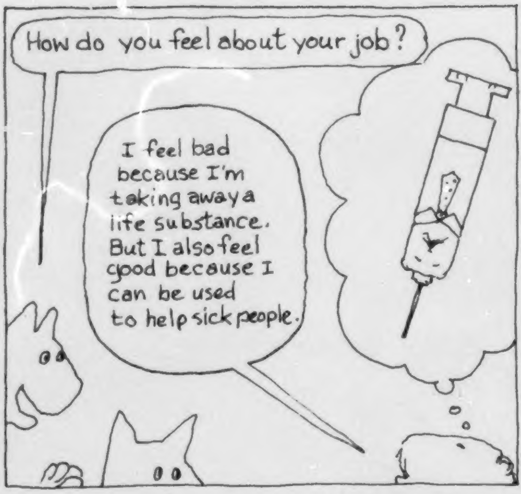

THE PROBLEM
Here's our problem. How do we control fires in High-rise office and apartment buildings?
FACT FINDING
* PUTTING OUT SMALL FIRES IMMEDIATELY
* CONTROLLING LARGE FIRES
* GETTING THE PEOPLE OUT.
What's the REAL problem?
Those buildings are just like chimneys!
GET RID OF OLD IDEAS
Who's got an old idea they want to get rid of?
We could fireproof everything, but offices are filled with paper.
More water or foam sprinklers but that's expensive and messy.
WISH STATEMENTS
Who wants to try stating a perfect goal?
How about an instant snuffer?
We need to make fires impossible.
We should make it so that fires would be afraid to start.


Find Analogies
Do these wish statements suggest analogies to anyone?
I see a hand dropping down and smothering the fire.
How about blankets on the ceiling that drop down like a spider web?
Yeah! Wet blankets! But how would the blankets get wet?
Like a tree. Did you ever try to light a green log? Trees are full of moisture. Thousands of tiny tubes carry moisture up from the ground.
Super! We could turn the building into a tree and we would'nt need any pumps or electricity or sprinklers. I see thousands of delicate tubes in the ceiling. They're filled with water drawn from a tank in the basement. When it gets too hot...
EXPLOSION
* STUFF THAT BURNS
* FUEL FOR THE FIRE: OXYGEN
* PEOPLE
* THE BUILDING
Good! Lets stop for a minute and explode the problem into parts.
Find Analogies
Who would like to try another analogy? What does the explosion suggest?
Getting rid of the oxygen. Maybe a suction pump.
Let's try nature. How about mosquitos? An elephant's trunk? Bees take nectar from flowers with suction.
I see a hypodermic needle in reverse.
Say more about that. What do you mean?
A needle can be used to take blood out. It can be used to draw blood out of a vein.

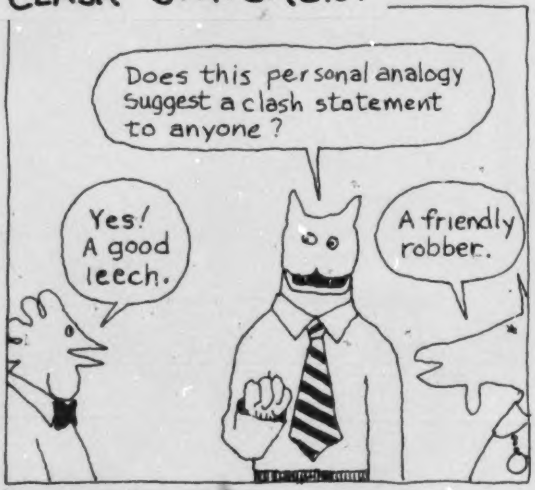
Lesson 16

PERSONAL ANALOGIES

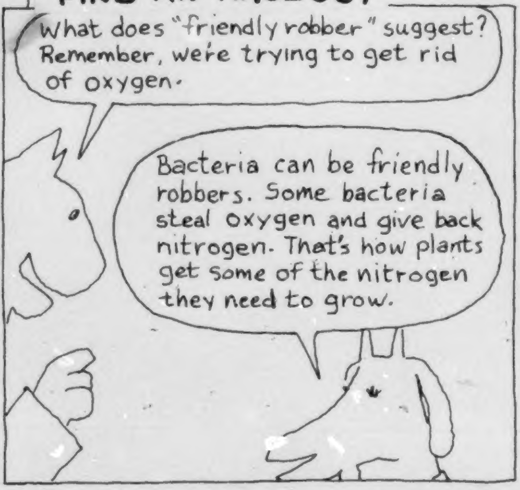

Who would like to pretend to be the thing?
I'd like to be a needle. I put my sharp end in the skin. Then I take a deep breath and the blood comes out like soda creeping up a straw.


How do you feel about your job?
I feel bad because I'm taking away a life substance. But I also feel good because I can be used to help sick people.

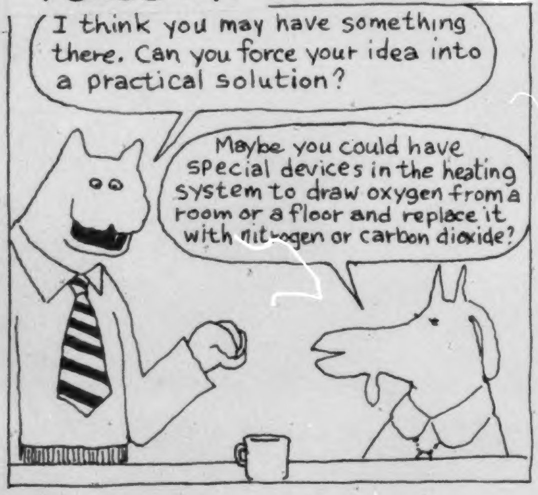
CLASH STATEMENT


Does this personal analogy suggest a clash statement to anyone?
Yes! A good leech.
A friendly robber.

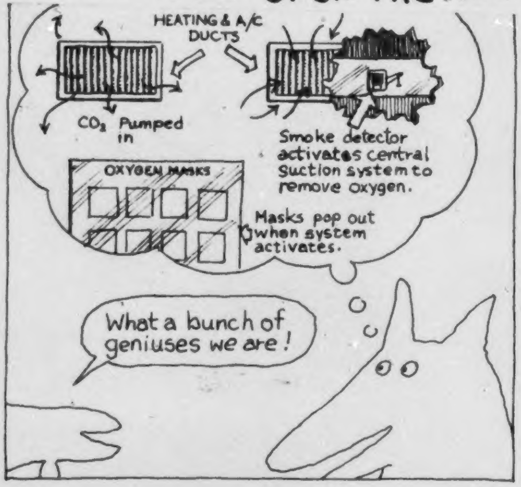
FIND AN ANOLOGY


What does "friendly robber" suggest? Remember, we're trying to get rid of oxygen.
Bacteria can be friendly robbers. Some bacteria steal oxygen and give back nitrogen. That's how plants get some of the nitrogen they need to grow.

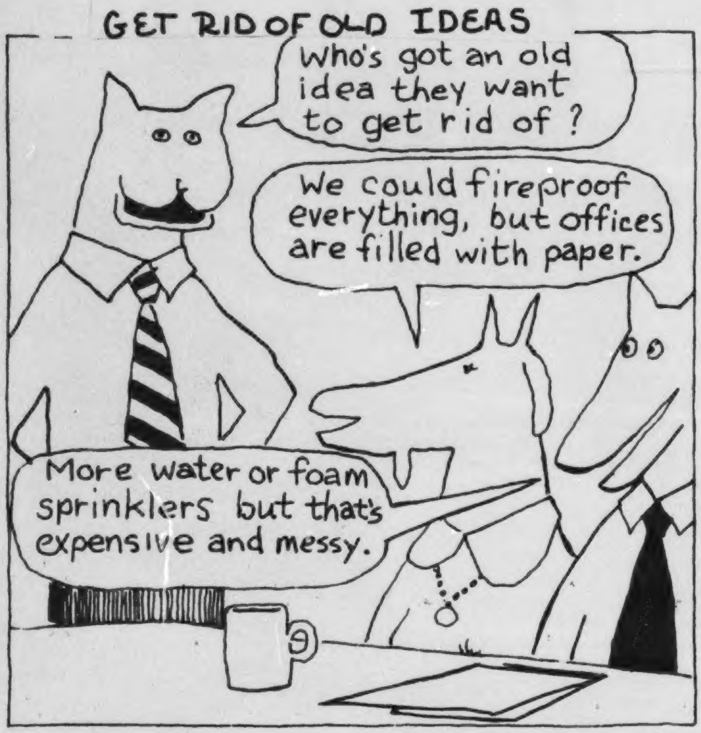
FORCE FIT


I think you may have something there. Can you force your idea into a practical solution?
Maybe you could have special devices in the heating system to draw oxygen from a room or a floor and replace it with nitrogen or carbon dioxide?

IMPROVEMENT UPON THE IDEA

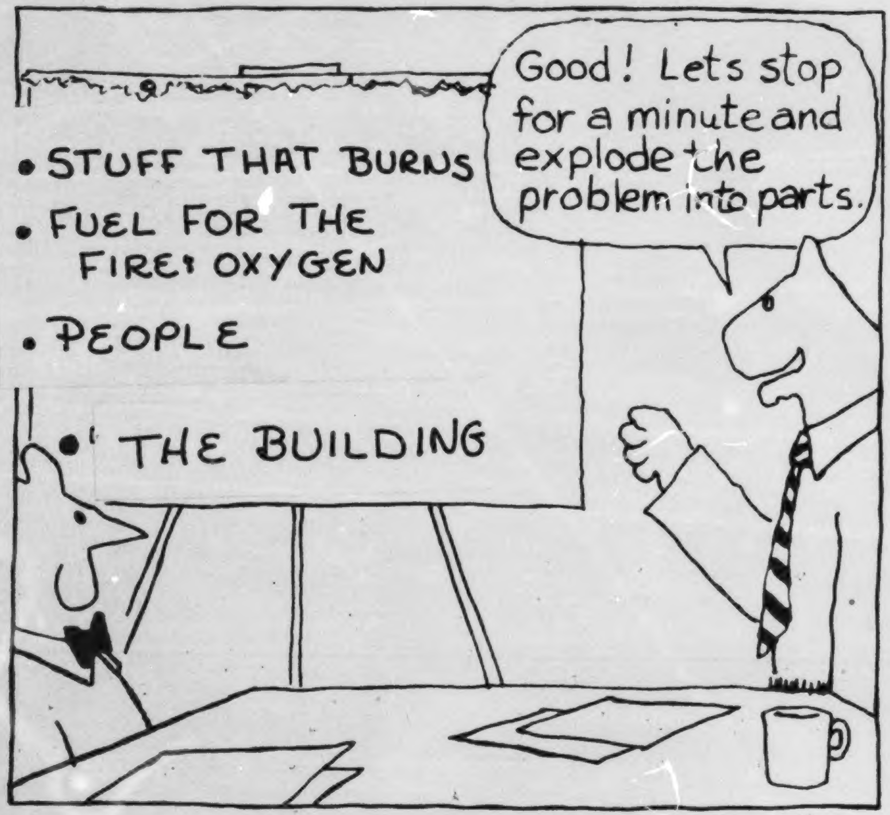

HEATING & A/C DUCTS
CO₂ Pumped in
Smoke detector activates central suction system to remove oxygen.
OXYGEN MASKS
Masks pop out when system activates.
What a bunch of geniuses we are!

Let's look back at a few of the steps in this excursion.


GET RID OF OLD IDEAS
Who's got an old idea they want to get rid of ?
We could fireproof everything, but offices are filled with paper.
More water or foam sprinklers but that's expensive and messy.

"GET RID OF YOUR OLD IDEAS" is a step that is often useful in an excursion. Sometimes a group member will have a favorite idea and will close his or her mind to any new ideas. One way to avoid this situation is to go around the table and have all the group members "get rid of" their old ideas. Once everyone has done this, the group is ready to go on to new and different ideas with open minds.

EXPLOSION

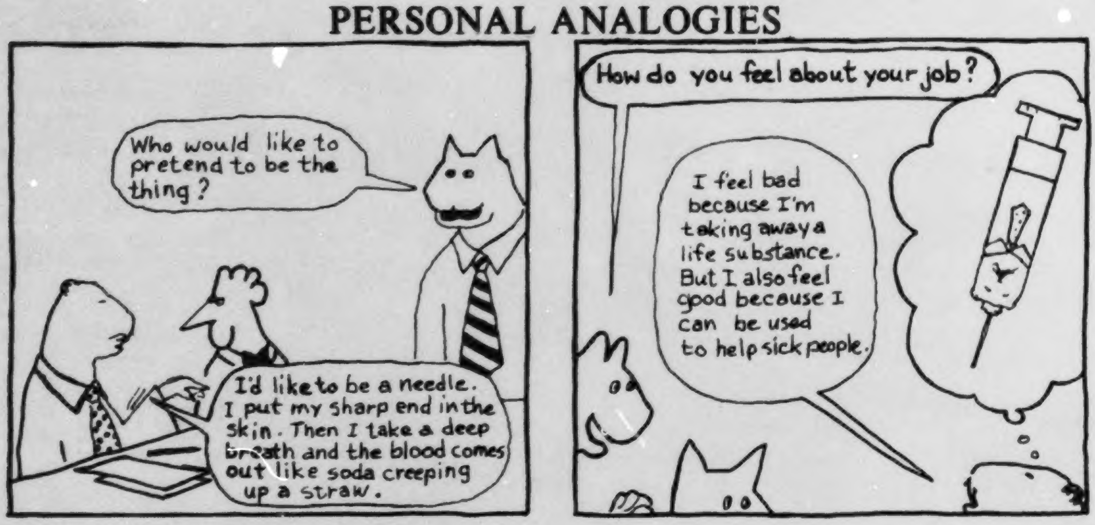

• STUFF THAT BURNS
• FUEL FOR THE FIRE: OXYGEN
• PEOPLE
• THE BUILDING
Good! Lets stop for a minute and explode the problem into parts.

Recall that you used "explosion" in earlier lessons to help you think of ways to make changes. In an analogy excursion, explosion can help you to name the parts of the problem that might be changed and help you look for possible analogies.

DIRECTIONS:

Do the exercises on pages H-22 and H-23.

PERSONAL ANALOGIES


Who would like to pretend to be the thing?
I'd like to be a needle. I put my sharp end in the skin. Then I take a deep breath and the blood comes out like soda creeping up a straw.
How do you feel about your job?
I feel bad because I'm taking away a life substance. But I also feel good because I can be used to help sick people.

Sometimes you may have difficulty thinking of wish statements and analogies for a problem because you don't understand the problem well enough. One way to get to know a problem better is to try to step inside your problem and experience it yourself. There are three ways to do this: Be the thing, be an analogy, and be the problem.

Suppose that you wanted to design a garbage can that won't tip over and spill — a tip-proof garbage can. Here are some of the personal analogies that you might try in order to understand the problem better:

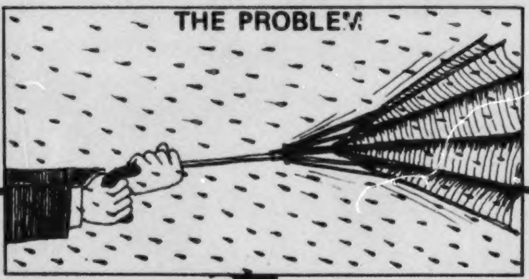
- *Be the thing.* Pretend to be a typical garbage can. How do you feel? What does it feel like when you get knocked over, bent out of shape, and lose your lid? What do you wish for to protect yourself? Take a minute to stand up and pretend to be a garbage can with a problem.
- *Be an analogy.* What does a tipping garbage can remind you of? How about a child's milk cup or a potted plant or a circus ride? Pretend to be the analogy. How are you like a tipping garbage can? How are you different? Do you have the same problem or have you solved it somehow? Take a minute and pretend to be an analogy.
- *Be the problem.* The key phrase in the problem is "tip-proof." What does "tip-proof" remind you of? How about a turtle or a child's punch toy? Pretend to be tip-proof. How do you do it? Stand up for a minute and act out being tip-proof.

Did these personal analogies suggest ideas to you? Can you now design a tip-proof grabage can?

What personal analogies could you act out in order to think of ideas for designing a windproof umbrella?

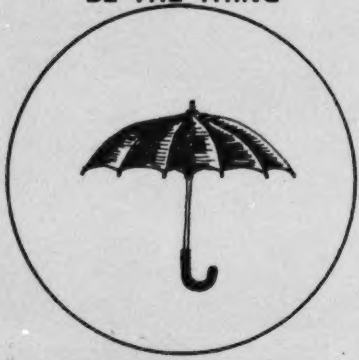
Lesson 16

DESIGN A WINDPROOF UMBRELLA



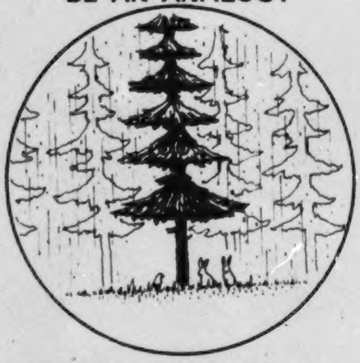
Key word = windproof

BE THE THING



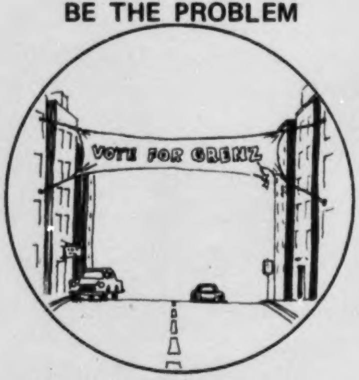
- Show us and tell us what you look like and how you work.
- What seems to be your problem?
- Show us what happens when you're experiencing your problem.
- Tell us how you feel about your problem.
- What do you wish for? What do you think you need in order to be windproof?

BE AN ANALOGY



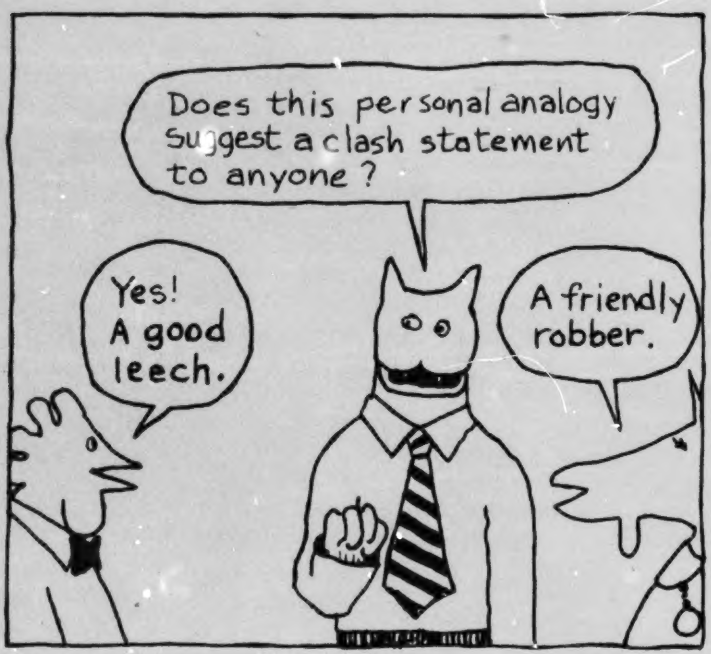
- Show us and tell us what you look like and how you work.
- In what ways are you like an umbrella?
- In what ways are you different from an umbrella?
- Show us and tell us how you handle rain and strong gusts of wind.
- What advice do you have to give that might help us design a windproof umbrella?

BE THE PROBLEM



- Show us and tell us what you look like and how you work.
- What seems to be your problem?
- Why is your problem like the umbrella's problem?
- Show us what happens when you're experiencing your problem.
- Tell us how you feel about your problem.
- What do you wish for? What do you think you need in order to be a better banner?
- How could you use this idea to design a windproof umbrella?

CLASH STATEMENTS


Does this personal analogy suggest a clash statement to anyone?
Yes! A good leech.
A friendly robber.

A CLASH STATEMENT is an unusual combination of words. Clash statements are like wish statements but they are expressed in two words that have opposite meanings.

Recall the problem about how to bring the astronaut back into the space capsule from the orbit in space. What was needed was a:

flexible pole
or a *rigid rope.*

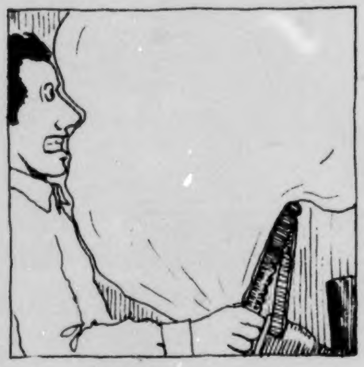
These phrases can also be called contradictions or conflict statements. In a contradiction, one characteristic can't be true if the other is true and vice versa (honest liar, white blackboard).

Sometimes looking for contradictions (clash statements) can help you solve the problem.

THINKING OF CLASH STATEMENTS

How did auto safety engineers think of the idea of the air bag? Here's how it might have happened.

1st engineer: *How can we reduce head injuries in collisions?* (problem statement)



2nd engineer: *We could put more padding in the dashboard or make the seat belt laws tougher.* (old ideas that won't work)

1st engineer: *What we need is to have an* *instant* *seat belt.* (wish statement)

2nd engineer: *That reminds me of the boxing glove that always comes from nowhere and knocks people out in cartoon shows.* (analogy)

1st engineer: *Great! But remember, we can't install anything that might hurt people.*

DIRECTIONS:

Can you think of a clash statement that might help these engineers think of ideas? RECORD YOUR IDEA IN YOUR NOTEBOOK.

If you need a hint, read the statement below.

One possibility might be "a soft punch in the mouth."
Can you think of another clash statement for this problem?

Let's try another problem.

1st engineer: *How can we find a way to cut the grass around trees and buildings?* (problem statement)

2nd engineer: *Mowers or clippers with metal blades don't work — trees get sliced, blades break and it's slow work.* (old ideas that don't work)

1st engineer: *Maybe we need a less destructive mower.* (wish statement)

2nd engineer: *Sure. Something like a child's rubber knife.* (possible analogy)

DIRECTIONS:

Write two clash statements in your notebook. Then do the exercises on page H-24.

MORE INVENTIONS

Each paragraph below describes an interesting characteristic of a member of the animal kingdom. Read the first description.

> The fly has delicate sensors in its antennae. The sensors measure the speed of the wind. When the fly senses a strong wind, it slows down. Without these sensors, a fly might become unbalanced in a strong wind.

DIRECTIONS:

Does this fact suggest a possible invention to you? Think about it. Use your imagination. DESCRIBE YOUR INVENTION IN YOUR NOTEBOOK. DO THE SAME FOR EACH OF THE FOLLOWING DESCRIPTIONS.

1. A fiddler crab has a set of eyes placed at the top of long stalks attached to its head. These stalks make the crab able to see in almost every direction. Also, the stalks can be raised and lowered for protection.

   Describe your invention in your notebook.

2. Termites live in nests that are about three feet underground. To get air, they build a number of airshafts. They maintain the high temperature they need to survive (86°F) by growing fungus gardens inside their nests.

   Describe your invention in your notebook.

3. Bats feed on moths. Moths are very sensitive to vibrations. When moths "hear" an approaching bat, a signal is sent to the moth's brain and the moth drops to earth where it "plays dead" until the bat has left.

   Describe your invention in your notebook.

4. A rattlesnake can catch mice and other prey that it cannot see or hear. A rattlesnake has small cavities on either side of its head which are covered with a thin skin. In the skin are thousands of sensory nerves that are sensitive to heat. Not only can the snake sense the presence of a warm-blooded animal, but it can tell its location, its size and its shape as well.

   Describe your invention in your notebook.

DIRECTIONS:

Make up a paragraph and an invention on your own. Then complete page H-25 and continue reading, in the Lesson Book, pages 114-121.

HOW TO BE A LEADER IN AN EXCURSION GROUP

Your duties as a leader in an excursion group will be different from those you have carried out in other lessons.

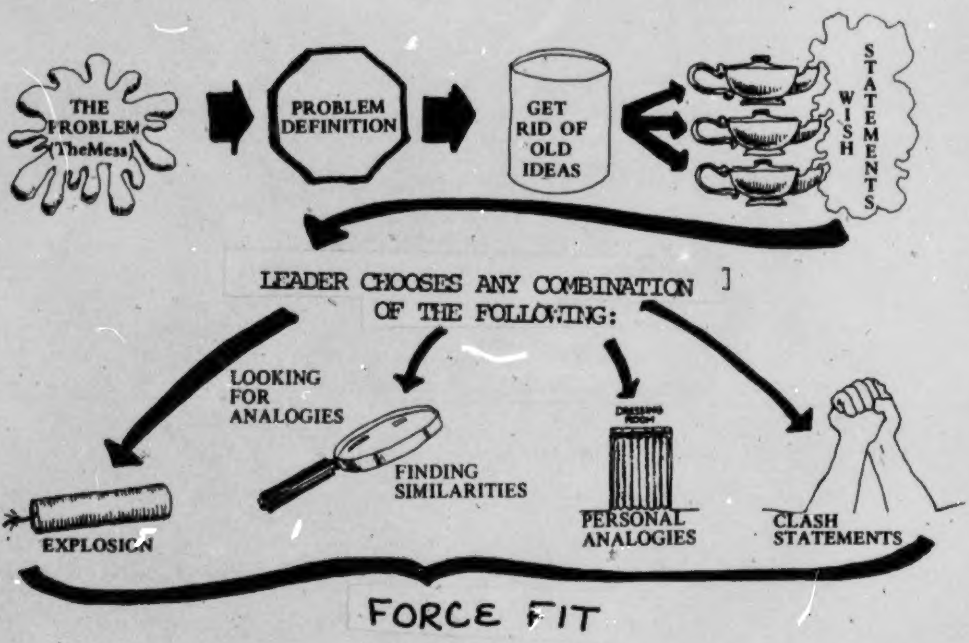
In an excursion group, the leader takes charge of group activities. The leader chooses the questions to ask and the methods to try (looking for analogies, wish statements, personal analogies, explosion and clash statements). The leader directs group progress.

Here is a list of do's and don'ts.

PLEASE DO NOT:	PLEASE DO:
• be critical	• be encouraging, give hints
• give orders	• ask questions
• give solution ideas	• ask for solution ideas
• lose track of the problem definition	• remember all of the methods
• go to sleep	• move the group from step to step, method to method

Here is a diagram of the excursion process:

STAGES OF AN EXCURSION


THE PROBLEM (TheMess)
PROBLEM DEFINITION
GET RID OF OLD IDEAS
WISH STATEMENTS
LEADER CHOOSES ANY COMBINATION OF THE FOLLOWING:
LOOKING FOR ANALOGIES
FINDING SIMILARITIES
EXPLOSION
PERSONAL ANALOGIES
CLASH STATEMENTS
FORCE FIT

ANALOGY EXCURSION II

The script below presents an analogy excursion taken by a problem-solving group. The excursion has sign posts along the way. Each sign post tells where the group is going and what it has to do to get there.

Cast of Characters

Sandy	Director of the Association for Better Housing. Sandy has come to the group in hopes of getting help with his/her problem.
Lee	Group leader. Lee reads the signposts, chooses the route, and decides when to stop, go, or change direction.
Chris Fran Dale Andy	These are the four main characters. They are the idea people. Each has a different strength, a different view point and a different set of experiences and interests. When they work together well, they surprise themselves with their imaginative ideas.

Script

Lee: Sandy, why don't you tell us about...

THE PROBLEM

Sandy: Basements are a wasted resource. Most basements are cold and damp. Many basements become flooded whenever it rains. When you add it all up, it comes to a great deal of wasted space that people could use for living space. We would like to find a way to make basements waterproof.

Lee: Let's do some...

FACT FINDING
What questions do you need to ask in order to understand the problem fully?

Chris: Does it make any difference where the houses are built?

Fran: What are the houses built of?

Dale: When do they get flooded?

Andy: Why do the walls let the water in?

Sandy: All kinds of houses in many kinds of places have flooded or damp basements. It doesn't seem to make much difference what materials are used; the water always gets in there somehow.

Lee: Okay, let's...

GET RID OF OLD IDEAS
State the easy and obvious ideas and tell why they don't work.

Andy: Make basement walls thicker.

Chris: No matter how thick, the water would still seep through.

Dale: Use waterproof paint on the inside of the walls.

Fran: The water would build up behind the paint. It might work at first, but not in the long run.

Lee: *(Ask the rest of the class if they have any ideas they want to get rid of.)*

Lee: The next step is to make...

WISH STATEMENTS
If you could have anything you want, what would you wish for?

Chris: I wish basements could grow to be waterproof.

Andy: I wish that it wouldn't rain near the house.

Fran: I wish the walls could mop up themselves.

Lee: *(Ask the class if they would like to contribute some wish statements.)*

Lee: The next step is to...

FIND SIMILARITIES
"Who else has a problem like this one?"
"What does this problem suggest?"

Andy: This problem reminds me of building a dam.

Dale: I think that the problem suggests a beaver filling holes with mud and sticks.

Fran: The problem reminds me of an old bucket.

Chris: Yeah! We need a leak stopper.

Andy: A hole filler.

Dale: Maybe we need to build a dike to keep the water away like they have in Holland.

Lee: Why don't we try an...

> EXPLOSION
>
> Find the parts of the problem that could be changed.

Andy: The ground outside the basement.

Chris: The water in the ground.

Dale: The basement walls.

Fran: The paint on the walls.

Andy: The spaces between the bricks.

Dale: The tiny spaces in the bricks.

Lee: *(Ask the class to name any other parts that could be changed.)*

Lee: Let's try...

> LOOKING FOR ANALOGIES
>
> "What does this problem suggest?" Think of inventions or things in nature that seem to be like this problem. How does nature solve a problem like this one?

Andy: Bricks have tiny holes like sponges.

Dale: Ducks have glands that squirt oil to keep water off their feathers.

Fran: Some things get bigger when they're wet like chewing gum, tea leaves, seeds, dried fruit or noodles.

Chris: People pop up umbrellas when it rains.

Lee: *(Ask the class for additional analogy ideas.)*

Lee: I'd like to offer some hints. What do plants do to keep water out or take water in? Can anyone think of a plant that holds water well? How is it built? Can anyone think of plant analogies? *(Ask the class to join in.)*

We have "animal" and "vegetable," how about "mineral"? Any analogies from geology or geography? *(Ask the class to join in.)*

How can we...

USE ANALOGIES
Think of ways to find and use analogies.

Chris: Put sideways umbrellas on the basement walls.

Fran: Plant a garden in the bricks. Seed the bricks with something that will grow to fill up all the spaces as soon as the bricks get wet.

Dale: Make duck bricks. Put a coating of oil on the outside of the bricks.

Andy: Make living bricks — like sponges — they would spit the water back into the ground.

Lee: Great ideas! Can anyone think of even wilder analogies? Can anyone think of other ways of using an analogy to solve this problem? *(Ask the class to join in.)*

Lee: Let's try to create some...

PERSONAL ANALOGIES
Be the thing. Be the part of the problem
you want to change. Describe how you feel.

Andy: I'm a sponge. I pick up lots of dirt and water. I keep the dirt, but I send the water back. Part of me is calcium. When there's so much water that I can't spit it out fast enough, the calcium takes the water and makes — what do you call those things — those rock icicles?

Lee: Stalactites and stalagmites.

Andy: Right. And they fill up parts of me. When I'm full of dirt and calcium "icicies," I die. But that's OK, because by then I'm as solid as a coral reef.

Fran: Let me try one. I guess I'm not alive like a sponge. But I did grow — I wasn't built. I was grown in a laboratory the same way that penicillin or crystals are grown. I was very young when I was planted at the house site. I was skinny and fragile. But each time it rained I grew bigger and stronger. I reproduced myself until I had filled all the available space. I became a crystal wall.

Lee: Would anyone like to pretend to be a "duck brick" or another kind of living wall? *(Ask the class to join in.)*

Lee: Let's try a...

CLASH STATEMENT
Put together two words or phrases that seem to be a contradiction.

Chris: Is "spongy brick" a clash?

Lee: I guess so — it's soft and hard and those are opposites.

Dale: Then the crystal wall can be described as "fragile strength."

Lee: Let's brainstorm clashes.

Chris: I'll start: Living death.

Dale: What's that mean?

Chris: It's like chewing gum stuck in a tooth cavity, or the way coral grows to make towers.

Fran: How about elastic plastic? Why can't we pour hot plastic on the bricks? The bricks would become solid after the elastic plastic drips into the spaces.

Dale: How about dry rain? The bricks could "rain" a kind of powder that goes solid when it gets wet.

Lee: Any other clash statements? *(Ask the class to join in.)*

Lee: I think we're ready for the last step. Let's make some...

FORCE FITS

Elaborate on a favorite analogy. Describe what it does and how it works.

Chris: I like the spongy brick full of calcium stalactites; but I don't really understand it, and stalactites take too long to grow.

Andy: I've been thinking and I've changed the idea a bit. Suppose you dig the hole for the basement and put in the posts to support the house. Between the posts you build the wall out of bricks which are very like household sponges, only they're made of soft plastic with cement-like powder sprinkled through the holes. While the house is being built the sponges soak up dirt and rain water. The cement powder hardens. If the sponges get too wet, you press them with big boards to force the extra water back out into the ground. If it rains a lot those first few weeks, you might have to spray more cement powder into the sponges. By the time the house is built, the basement walls should be solid.

Lee: Can we use that on old houses too?

Dale: If we had a thin layer of sponge bricks up against the inside of the old wall it might work, especially if we drilled the old wall with holes first.

Lee: What about the crystal wall?

Fran: I know crystals can be grown — usually in some kind of liquid, but...

Dale: Why not put the crystals inside the sponge bricks? They'd be better than cement powder.

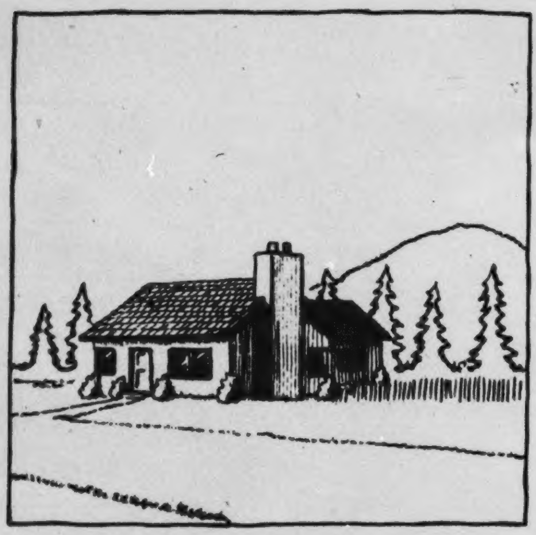
Fran: Yes, I think that would work. If the scientists could develop crystals that live on water, it would probably work well. Put tiny crystals into the sponge bricks, and after a couple of rainfalls you'd have walls as strong as quartz.

Lee: Would anyone in the class like to force fit another analogy into a practical solution? *(Ask the class to join in.)*

Lee: Sandy, do you think the Housing Association can use these ideas?

Sandy: Yes. Some of them were really good. I really had a good time. Analogy excursions are fun.

THE WINDMILL PROBLEM



The Cedar family lives in a small house on the outskirts of a Midwestern city. The Cedars would like to build a windmill on the small hill directly behind their house. They have read several books on windmills and believe that wind power would be a cheap and pollution-free way of providing electricity for their home.

The difficulty that the Cedars have with their idea is that the winds are not very steady in their part of the country. The wind may blow at 15 mph for half and hour and then slow to 2 mph for a period of time. Sometimes the wind blows very hard for an hour or two and then stops completely for a short period.

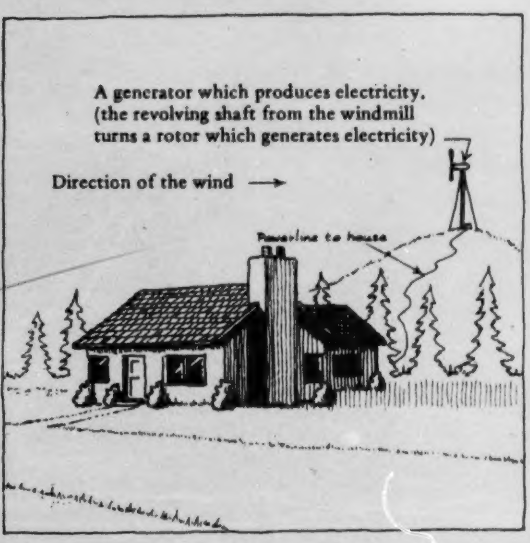
Not only does the wind stop and start but it changes direction as well. It might blow from the north for an hour then completely change direction and blow from the west or south for a while.

The Cedars must find a way to keep generating electricity even when the wind has stopped, and they must find a way to keep the windmill turning no matter what direction the wind is coming from. The Cedars do not wish to use a gasoline motor or any other power source that uses fossil fuels. In addition, they don't want to use batteries to store energy.

Can you help the Cedars with their problem?

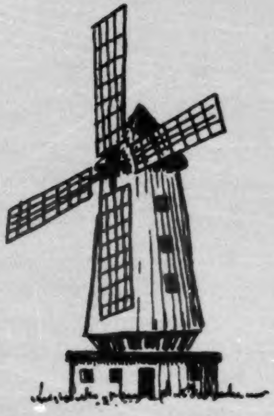
BEST COPY AVAILABLE

This is an example of a common windmill (blades or propellers attached to a shaft).

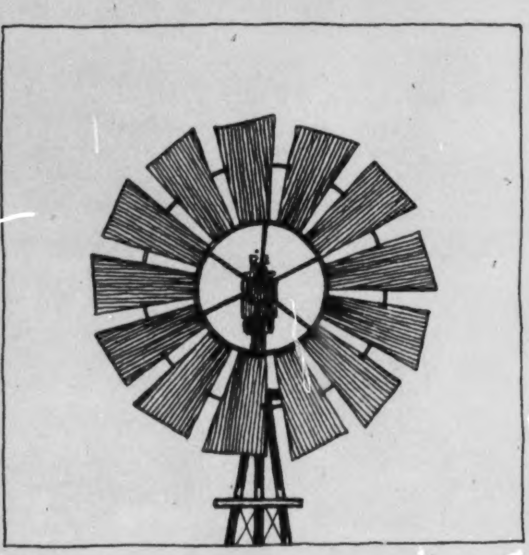

A generator which produces electricity.
(the revolving shaft from the windmill turns a rotor which generates electricity)
Direction of the wind →
Powerline to house

The windmill pictured above is just one example. Windmills can take on a variety of shapes and sizes. You may propose any type of windmill you wish.

Background information. Skim the following information. It may or may not be helpful to you for solving the Cedars' problem.



Here is an example of the traditional European windmill. Windmills like this one were used to grind corn or pump water. The entire windmill structure turned on its base. Horses were often used to turn the windmill into the wind.

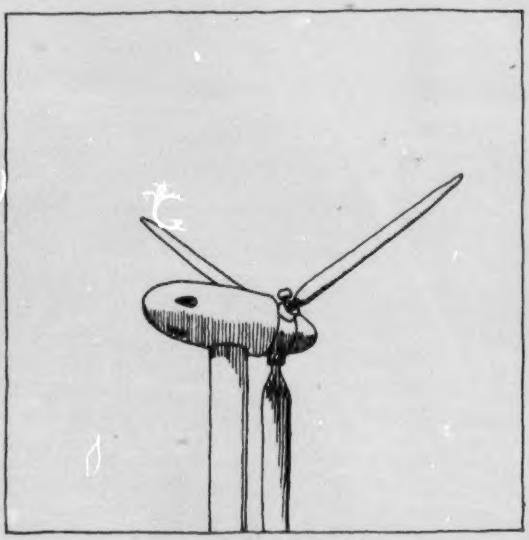


Windmills were popular on farms in the beginning of this century. Most were used to pump water although some were used for electrical power.

When power companies began to offer cheap electricity to farm areas, windmills disappeared. Recently, with rising energy costs, windmills are reappearing.

The modern wind turbine looks very much like a propeller. Only two or three blades are used for maximum power. However, the blades must face the wind to work properly, and storing energy for windless periods is still a problem.

Windmills and wind turbines have other problems as well. Sleet and snow can break propeller blades. High winds can cause the blades to turn so fast that the entire windmill assembly vibrates apart. In addition, metal windmills rust and wood windmills rot.



What the Cedar family needs is a strong windmill that will work in all conditions, always face the wind, and provide power even when the wind has stopped. You must figure out a way to do this without using motors or batteries.

THE WINDMILL PROBLEM
Tasks To Be Completed

DIRECTIONS:

1. **Choose a leader. [1 minute]**

2. **List at least three challenge statements. [3 minutes]**

3. **Write a broad terms problem definition. [2 minutes]**

4. **Brainstorm wish statements. Record the best three. [3 minutes]**

5. **Guided by your leader, spend the rest of the session doing the following: (Recorder takes notes.) [30-40 minutes]**

- **Look for analogies.** Describe at least four possible analogies.

Hints: 1– What are some ways of storing energy?
2– How do plants and animals use the wind – what shapes work best?
3– What are some human inventions made for using the wind?
4– What are some things that spin?
5– What are some things that always face the wind? How do they work?
6– What are some things that move after the "mover" has stopped?

- **Explode the problem into parts.** Complete an explosion diagram.
- **Personal analogies.** Act out at least three personal analogies.
- **Clash statements.** Record at least two clash statements.
- **Force fit solution ideas.*** Describe your best ideas.
- **Judge your ideas.** Complete a criteria chart. Select the best idea.
- **Draw and label your idea(s).** Draw and label your best idea. Use poster paper and magic markers if available.

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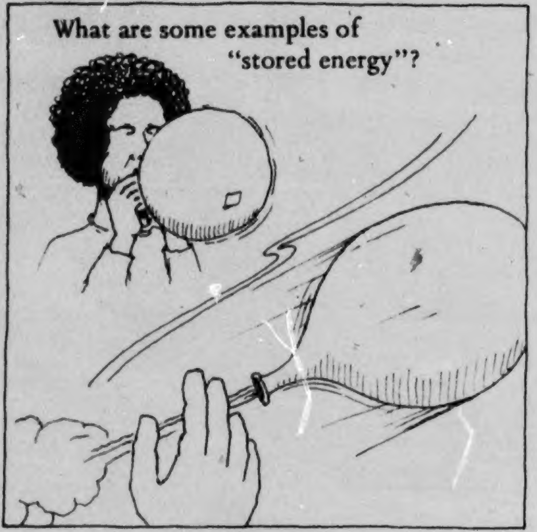
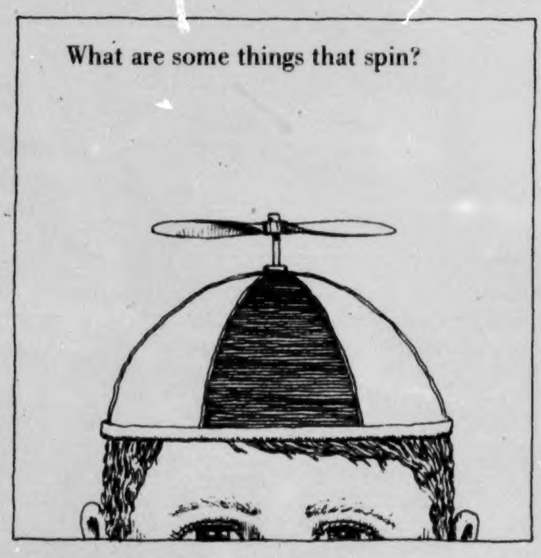
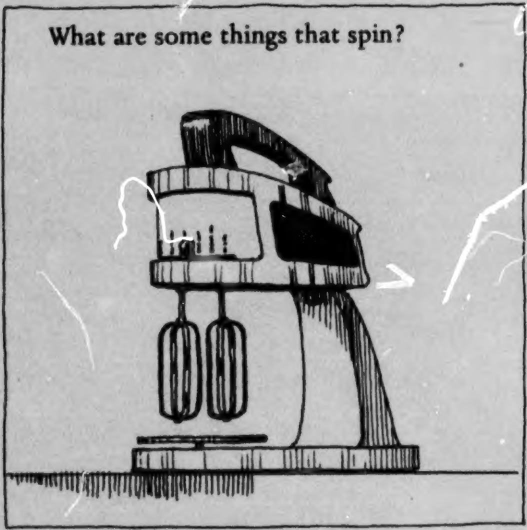
* When you reach this point, look over pages 126 to 129 for additional ideas or ways to improve your ideas.


What are some examples of "stored energy"?


What are some things that spin?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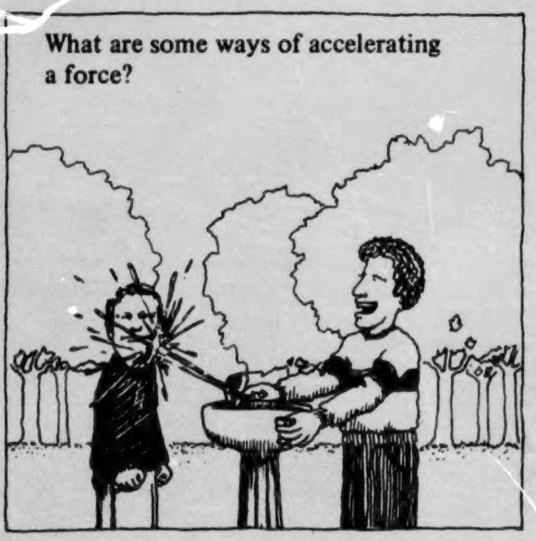
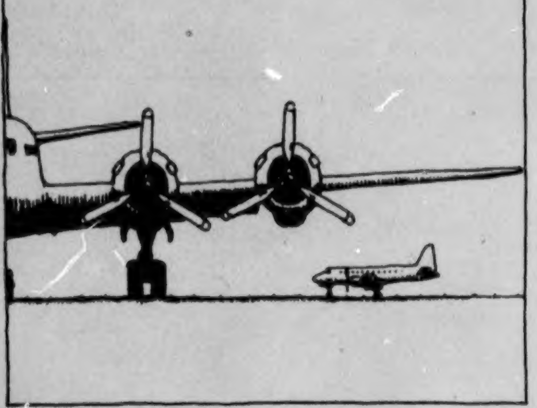
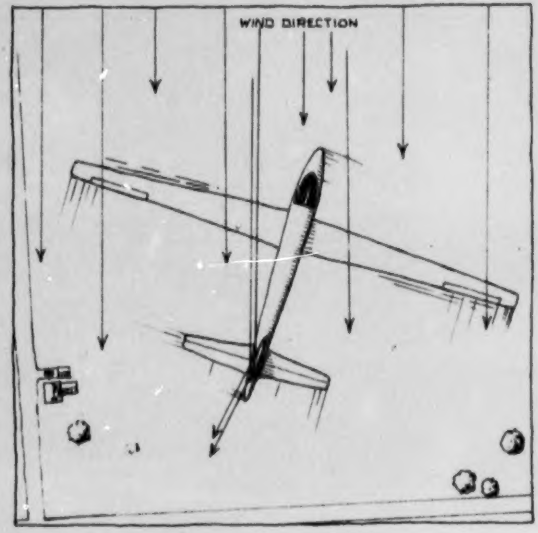
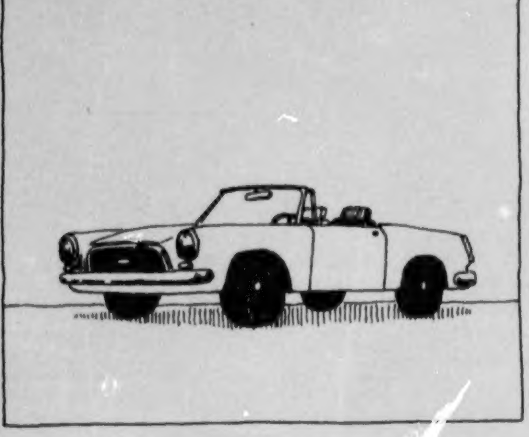

What are some ways of accelerating a force?

What does this illustration remind you of?

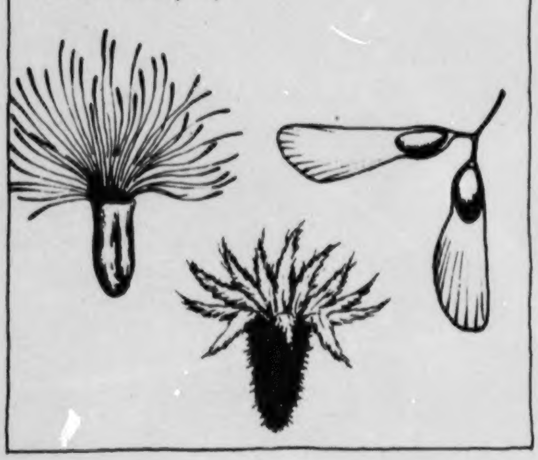




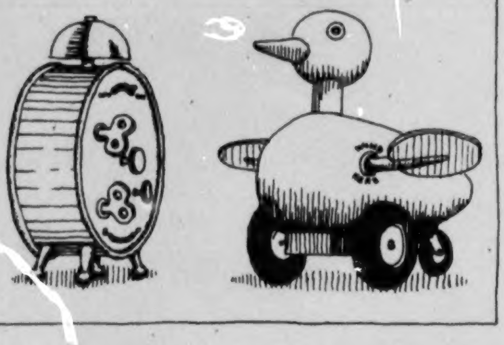
Some toy cars move by themselves without batteries. How do they work?



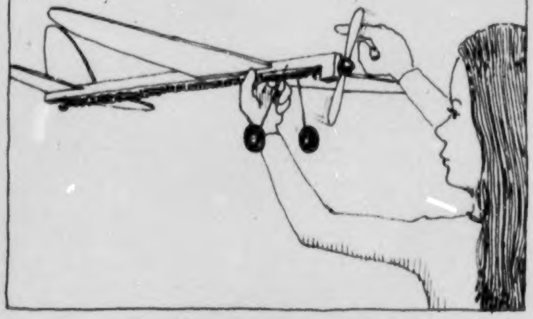
Three examples of winged seeds that rotate as they fly.



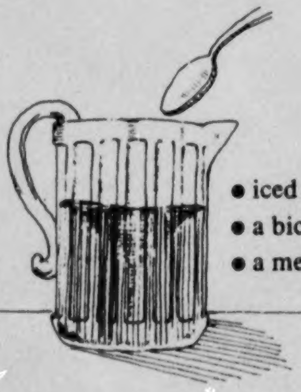
How can you make things move without an external power source?



What are some ways of storing energy?

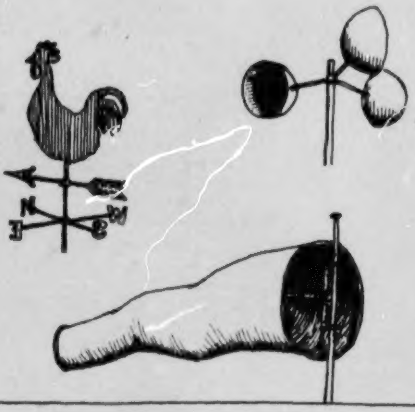


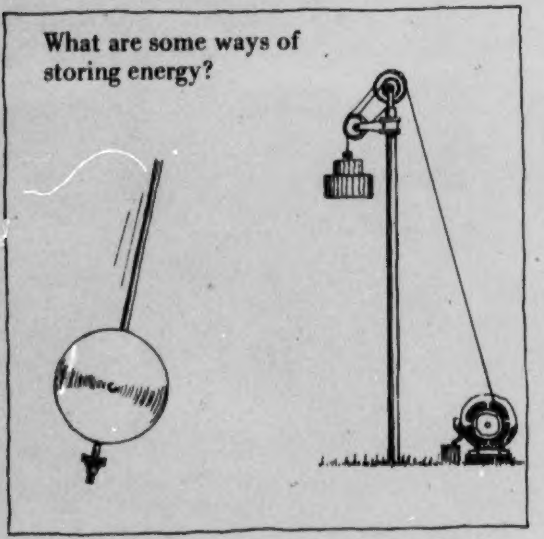
What kinds of things keep moving after the "mover" has stopped?



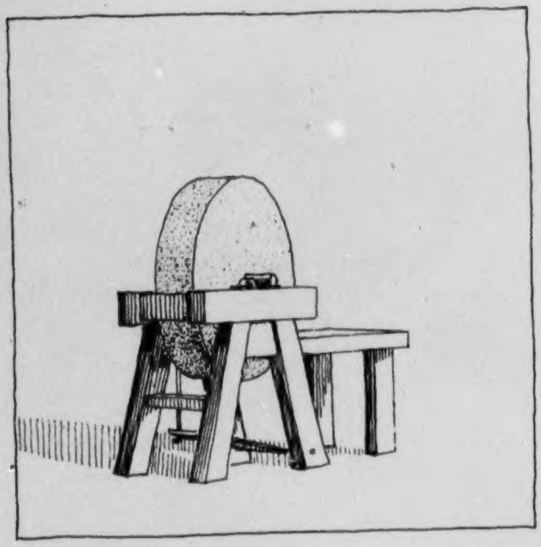
- iced tea in a pitcher
- a bicycle wheel
- a merry-go-round

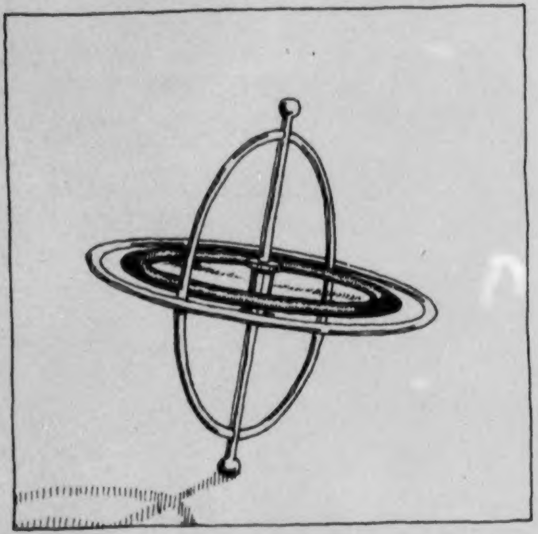
What kinds of things always face the wind?

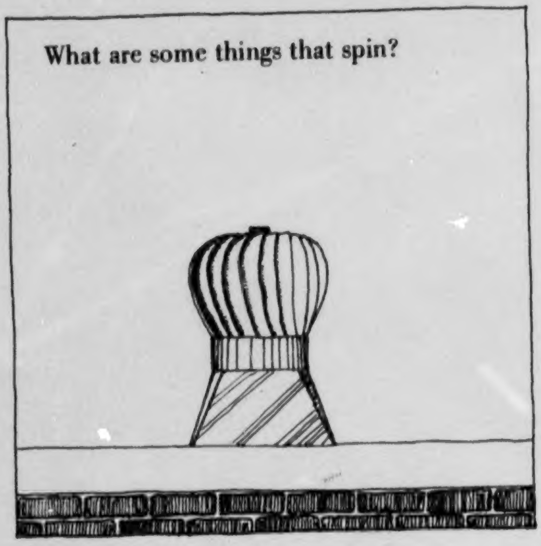




What are some ways of storing energy?







What are some things that spin?

TO: Members of the VISTA PLANNING COUNCIL

DATE: March 8, 1998

SUBJECT: Your assignment

In a few days, we will be breaking ground for the construction of the new Synthesis Computer. The computer, nicknamed Syncom, will be the largest and most powerful computer in the world.

Syncom will be located high in the Rocky Mountains in the Southwestern portion of the U.S. Thousands of workers will be needed to run the computer and its services.

The town that we will have to build to house these workers will be called Vista. With your help, Vista could be a very special town. With careful planning and imaginative ideas, Vista could be a clean, peaceful and pleasant community.

Because of its altitude and its isolation from other communities, ideas for conserving energy and other resources are especially important. We'd like you to begin your work with Vista by helping us design energy-saving housing units.

The pages that follow will give you additional background information on Syncom and Vista.

Thank you for your concern.

Barbara Chan

The Hon. Barbara Chan
Vice President of the United States
Honorary Chairperson, Project Vista

Project VISTA Background

The Synthesis Computer is the heart of the Vista project and the reason for its existence. When completed, Syncom will consist of 72 large, high-speed computers tied together in a network to form a supercomputer. Each of the 72 units has a "brain" and a "memory" big enough to hold twice the information in the Library of Congress.

Twelve units will make up the core of Syncom. Six will communicate with people by voice and teletype and six will organize the remaining 60 units and program them to solve economic, social and environmental problems.

The Environment for the Vista community was determined by the nature of Syncom. Syncom is very sensitive to physical shocks and electrical interference (sparks, radio waves, and "static"). To protect Syncom from these disturbances and from deliberate sabotage, it was decided to put it underground in an isolated and geologically stable area.

The selected location is a dry, mountainous area of the southwestern United States. The town of Vista will be built in a shallow, bowl-shaped valley to the south of a steep mountainside and connected by a tunnel to the computer facility deep inside. The winds blow from the southwest. Rainfall in Vista Valley averages only three inches a year, most of it from winter storms, and humidity is very low year round. The soil is thin and sandy and easily eroded down to clay and bare rock. The vegetation is sparse, consisting mostly of cactus, scrub grass, tumbleweed, and, higher up, scrub pine, juniper, and oak. Wild flowers bloom briefly after a rainfall. Small rodents like field mice and prairie dogs are common, as are the animals who feed on them, such as rattlesnakes, hawks, and an occasional coyote. The temperatures are extreme, with normal daily temperatures ranging from lows around 25°F to highs around 75°F in mid-winter and lows of 55°F to highs of 110°F in the mid-summer.

In general, the environment is harsh, but it has a certain kind of beauty, dominated by shades of red, yellow, tan and gray, with brilliant blue skies, clean air, and glorious sunsets. The environment is also very fragile (easily damaged). Scars on the landscape take many years to heal. Because of the lack of water, there is almost no one living in the region. When the road to Vista Valley is finished, it will be an 80-mile drive to the nearest settlement and 165 miles to the nearest city.

The Population of Vista Valley is still largely to be determined. It is expected that the basic industry, Syncom, will employ about 5,000 full-time scientists, engineers, technicians, administrators, secretaries, clerks, plumbers, electricians, security guards, and so on. The families of these workers will have to be provided for as will the hundreds of visitors and short-term workers who will be attracted to Vista. These people will need food, shelter, transportation, schools, banks, police, theaters, garbage collection, health care, clothing, newspapers, restaurants and thousands of other things.

Food, Water, Energy and Waste Disposal problems will have to be solved for the Vista community. With the price of gasoline climbing past $2.50 a gallon, the cost of importing all of the necessary food, water and energy by truck would be enormous. One possible way to ease the four problems of food, water, energy and waste disposal is to use greenhouse-type closed ecology units. A typical unit serves 10 to 20 families and contains a methane plant and a miniature indoor farm. The methane plant takes in food scraps, plant stalks, leaves, sewage, manure, paper and any other form of organic material. It uses bacteria to "digest" these materials, producing methane (natural gas), water, and high-quality fertilizer. When methane is burned, it produces carbon dioxide, water vapor and heat. It can be used for cooking, as a substitute for gasoline (in cars, electric generators, etc.), and to provide heat and hot water. But there won't be enough of it for all of these things. Additional energy sources will have to be tapped.

The water and fertilizer from the methane ganerator are used to grow plants and algae. The plants provide fruit and vegetables (and some grain, particularly corn) for human consumption. Edible garbage, edible plant scraps, and algae can be used to feed such animals as pigs, chickens, rabbits, and possibly goats or a cow. The algae can also be used to provide food for fish in small ponds. Evaporating water and the water exhaled by the plants and animals raise the humidity inside the structure. The condensation this creates on the external surfaces when the outside temperature drops is then trapped to provide some of the necessary drinking water for the townspeople.

The closed ecology unit thus can recycle water, wastes, garbage, and some trash. The unit can provide part of the energy, most of the fruits and vegetables, and part of the protein consumed within the community. Each unit, including the methane plant, orchard, vegetable plot, algae ponds, fish tanks, animal pens, and storage facilities, occupies one to four acres and takes three to six full-time workers or the equivalent to run it.

Residential Housing Units for Vista have to be designed to meet seven conditions:

(1) They must be pleasant to live in. Keep in mind that outdoor recreation will frequently be limited.

(2) They must be built with a minimum of imported materials.

(3) They must be strong enough to stand up to severe storms.

(4) They must be very inexpensive to heat and particularly to cool (air conditioning uses lots of energy).

(5) They must be nearly vapor tight to retain as much moisture as possible in this very dry climate.

(6) They must be integrated with the greenhouse ecology units, yet remain separate from one another to minimize the spread of pests.

(7) If solar and/or wind power are to be used, they must be included in the design of the buildings.

In addition to these seven conditions (criteria), you should also consider what sort of building material to use.

The chart below indicates some of the advantages and disadvantages of the materials available in Vista Valley. Which would you pick to make a wall that was strong, insulated, vapor tight, easy to build, and cheap? Why? What would the wall look like? How would you build it?

	STRENGTH	INSULATION	VAPOR-TIGHTNESS	EASE OF CONSTRUCTION	COST
WOOD	fair/good	good	poor	good	high
BRICK	very good	fair	poor	fair	high
STONE	good	very poor	poor	poor	low
FOAM	very poor	very good	good	good	high
PLASTIC SHEET	none	none	very good	very good	low
CONCRETE	good	poor	poor	fair	moderate
DIRT	poor	fair	poor	depends	very low
ADOBE	fair	fair	poor	fair	moderate

HOUSING PROBLEMS FOR THE VISTA PLANNING COUNCIL

You will have two class periods to design the housing units for the Vista community that automatically conserve heat and are easy to cool. You and your group may select any one of the following wish statements (they are underlined below). Skim all five problem statements below before the next class session.

Problem I

Design a housing unit that is underground but not underground. The ground is a very good insulator. The temperature ten feet below the surface of the earth can be several degrees cooler than the surface in the summer months. In the winter, it is warmer underground than at the surface. An underground house would be far cheaper to heat and cool than an above-ground house. But people do not like living without windows and a view. Can you design an underground house that has the advantages of being underground without the disadvantages of a lack of natural light and a view?

Your housing unit must provide space for 20 families (approximately 85 people), including a two-acre greenhouse.

Problem II

Design a housing unit with a roof that both reflects and absorbs. In the summer, when it is hot, a building stays cooler if its roof reflects the sun. In winter, the building will stay warmer if the roof absorbs the sun's heat. Can you design a roof that will reflect the sun when the air temperature is warm and absorb the sun's heat when the air temperature is cool?

Your housing unit must provide living space for 35 people, all of whom are over 60 years old. The unit must include a one-acre greenhouse.

Problem III

Design a greenhouse roof that both transmits and blocks the sun. Plants need light to grow, but in Vista, the blazing heat of the summer sun will quickly kill most plants. In winter, when the days are short and the sun is less strong, the plants need all the light they can get. Can you design a greenhouse that lets in (transmits) lots of light when the plants need it and keeps plants from burning when the sun is strong?

Your housing unit must provide living space for 18 families of different sizes. All of the children in this unit are under seven years of age. The unit must have a two-acre greenhouse.

Problem IV

Design a way to have solar heat on a cold winter night. Each of the Vista housing units will use solar energy to supply its heating and perhaps its cooling needs. The difficulty with solar heating is what to do at night or on cold, cloudy days. Can you think of a way to capture and store the sun's heat so that the housing unit would have all the heat it needs for nights and sunless days? The design must not include any other source of power, not even batteries.

Your housing unit must provide space for four families (16 people), including a small greenhouse.

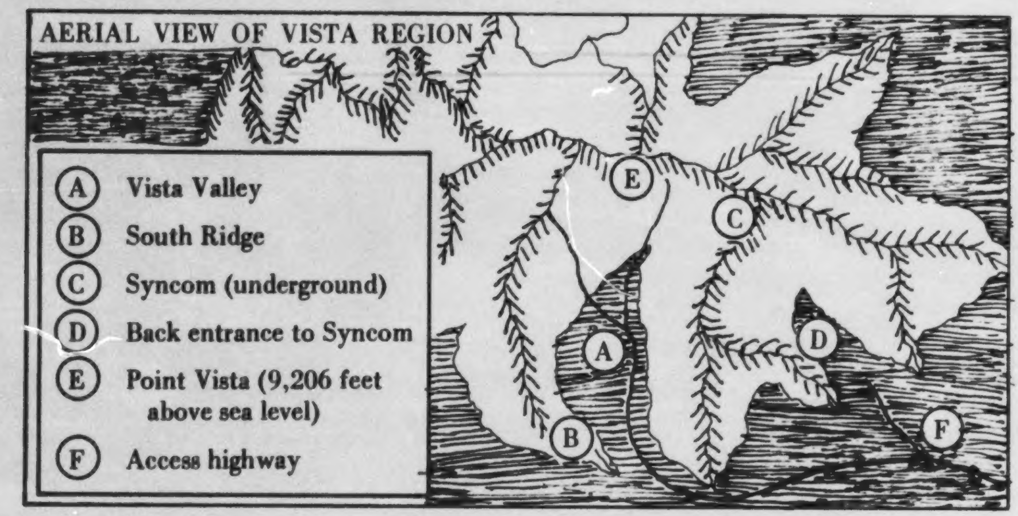
Problem V

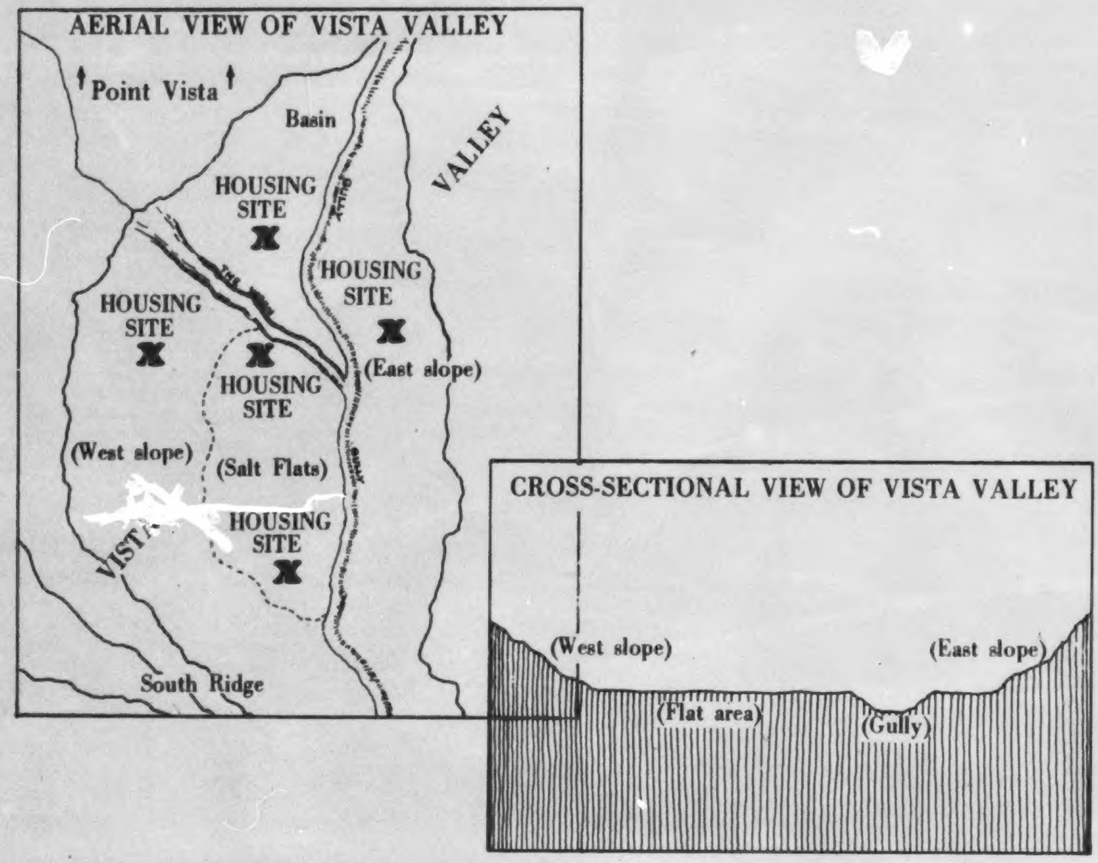
Design a solar collector for your housing unit that is big but doesn't get in the way. The Southwest has an ideal climate for using solar energy because most days are sunny in all seasons. Because of its altitude, the Vista area gets fairly cold in winter which means that the solar collectors would have to be quite large — at least one third the size of an average classroom for each family in the unit. Can you think of a way of designing a solar collector (or collectors) for the housing unit that would not block the view and would not block the sunlight needed by the greenhouse?

Your housing unit must provide space for ten families (40 people), including a one-acre greenhouse.

BEST COPY AVAILABLE

MAPS OF THE VISTA SITE


AERIAL VIEW OF VISTA REGION
Ⓐ Vista Valley
Ⓑ South Ridge
Ⓒ Syncom (underground)
Ⓓ Back entrance to Syncom
Ⓔ Point Vista (9,206 feet above sea level)
Ⓕ Access highway
A
B
C
D
E
F


AERIAL VIEW OF VISTA VALLEY
Point Vista
Basin
VALLEY
HOUSING SITE
HOUSING SITE
HOUSING SITE
HOUSING SITE
HOUSING SITE
(East slope)
(West slope)
(Salt Flats)
VISTA
South Ridge

CROSS-SECTIONAL VIEW OF VISTA VALLEY
(West slope)
(East slope)
(Flat area)
(Gully)

VISTA HOUSING PROBLEMS

DIRECTIONS:

1. Choose one of the problem statements on pages 134 to 135.

2. When you have been given your assignment, your group leader should read the problem aloud to the rest of the group.

3. Using the map on page 136, choose a site for your housing unit.

4. Conduct an analogy excursion. Begin by giving alternative WISH STATEMENTS to the one you have been given, then do each of the following:
    - FIND ANALOGIES – record at least four.
    - PERSONAL ANALOGIES – do at least three.
    - CLASH STATEMENTS – record at least two.
    - FORCE FIT – describe at least three solution ideas.

5. Present your idea to the class. At least one solution idea should be illustrated and labeled. The reporter should cover the following points in the presentation:
    - problem statement
    - analogies that you considered
    - your best clash statement
    - your favorite solution idea
    - an explanation of the final design and how it will work.

A HOUSE THAT IS UNDERGROUND BUT NOT UNDERGROUND

What kinds of vegetables grow underground? What are their shapes?

What kinds of animals live underground?

What people in ancient times lived underground? What were their homes like?

How are animals insulated from temperature extremes and moisture?

What animals live above the ground in underground homes?

How are plants insulated from temperature extremes and moisture?

What kinds of homes are built of earth?

How could you state this problem as a reversal?

How do plants live both under and above ground?

What are some ways of being in two places at once -- part in, part out, part up, part down?

What are some ways of viewing something without really viewing it?

What animals carry their homes around with them?

How could you have an underground view?

What is it about the earth that makes it such a good insulator?

Lesson 20

A ROOF THAT REFLECTS AND ABSORBS

How do things change color?

What colors reflect sunlight?
What colors absorb sunlight?

How do flowers react to the sun? Why?

What are some ways to block sunlight?
What kinds of things can both block or let in light?

What ways are there to reflect sunlight?
What ways are there to absorb sunlight?

How do animals change color?

How is sunlight absorbed in nature?

What human inventions are designed to measure or regulate heat or light? How do they work?

How could you make the roof change itself in the sun?

What are some things that melt easily in sunlight?

How do animals keep from getting too hot?
How do animals keep from getting too cold?

How does a flounder change its color to match the color of the ocean bottom?

What are some verb changes for reflect?
What are some verb changes for absorb?

What materials reflect well?
What materials absorb well?

How does skin change color?

A GREENHOUSE THAT TRANSMITS AS WELL AS BLOCKS

How do plants control the amount of light reaching sensitive parts?

What are some verb changes for "transmit"? What are some verb changes for "block"?

What are some ways of controlling how much light passes through glass?

What are some machines or devices that are "sensitive" to light?

Sometimes one side of a house is hotter than another side. How could this fact help to solve the problem?

What do animals do when the sun is very hot?

What do you do when the sun shines very brightly?

How do you make a room cooler if you don't have an electric fan or air conditioner?

What are some ways to measure light? What are some ways to measure heat?

How could you have summer in the winter or winter in the summer?

Can you restate the problem in three ways so that each way suggests a different way of attacking the problem?

How might you keep plants from scorching?

What blocks the sun and heat in nature?

What do you do to protect sensitive body parts from the bright sun?

FINDING SOLAR HEAT ON A COLD WINTER NIGHT

How do animals keep warm in the winter?

Why is the ocean cold on a hot day in June and warm on a cold day in September?

How does a sauna work? What makes the room so warm?

How do fish live and breath in an iced-over pond?

Why did the Indians of the Southwest build homes with such thick walls? What were these walls made of?

How do hibernating animals keep from freezing?

Why are greenhouses so warm on sunny days?

Which side of a house is the warmest during the day: north, south, east or west?

How did people keep warm at night in ancient times?

How do birds keep warm on a cold day?

On a hot summer day, what kinds of things are hottest to the touch?

What kind of fabric can be both warm and cool?

How do plants stay alive in the winter?

What is the warmest kind of non-electric blanket?

SOLAR COLLECTORS THAT DON'T GET IN THE WAY

How do sunflowers get the most out of the sun?

Why are some rooms in a house always warmer than others in the summer?

How do flowers collect sunlight?

How can you start a fire with just a piece of glass?

What are some ways of making a roast cook more quickly in the oven?

What are some ways to focus sunlight?

Where is the sun the strongest?

Why is it not a good idea to walk on a tar-paper roof in your bare feet on a sunny day?

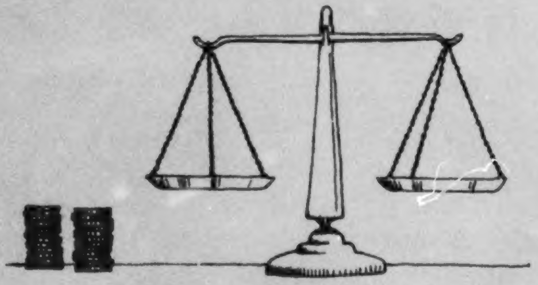
How do people increase the effect of the sun in order to get a fast tan?

Why is it always so hot in a closed car in the summer?

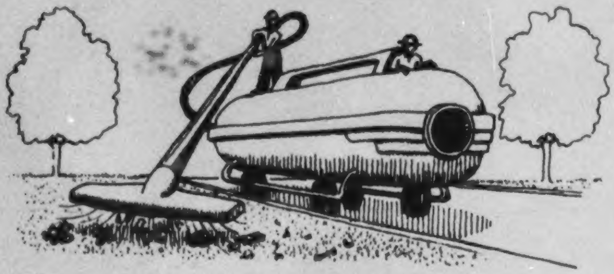
Why is it always so hot in the attic of a house?

What kinds of things get warmest in the sun?

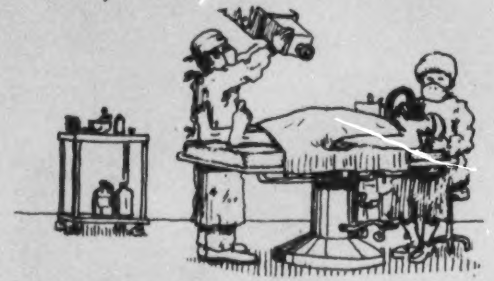
Lesson 20



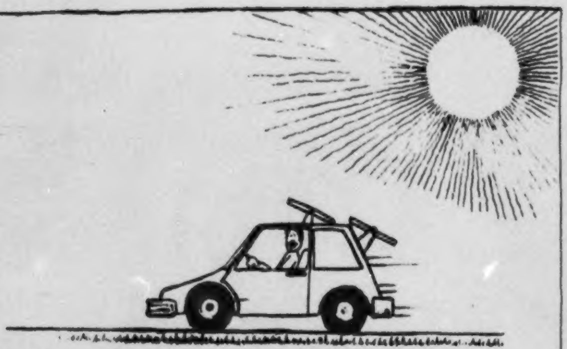
You have 24 coins. One coin is slightly heavier than the other 23 which all weigh the same. Your job is to figure out how to find the heavier coin by using the balance. The balance can be used to weigh any two sets of coins. How could you find the heavy coin by using the balance only three times?



It costs 500 million dollars each year to pick up litter along roads and highways. Design a machine that could pick up roadside litter without leaving the roadway.

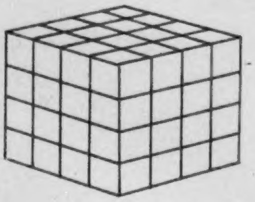


Low-strength laser beams can pass through the human body without injuring the patient. By increasing the power of the laser, diseased tissue such as tumors can be removed (burned) without surgery. However, to do this, the beams would have to be so strong that other tissue in their path would be burned. How could you use laser beams to burn a tumor without harming other tissue?

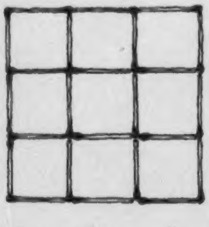


If there were solar-powered vehicles, how could you recharge the batteries with solar power at night?

Alice got a flat tire on a cliffside road ten miles from the nearest town. After she put the spare on, she accidentally kicked the four lug nuts over the cliff. [Lug nuts are used to attach the wheel to the car.] There are no other cars on the road and no buildings nearby. How could Alice get her car safely to town?



If all six sides of this cube were painted red, how many cubes would have 3 red sides, 2 red sides, 1 red side, no red sides?



Remove eight matches so that you leave only two squares.

MAKING CHANGES

OBJECTIVES – UNIT IV

What you should be able to do when you complete each lesson of Unit Four:

Lesson 21

- Know the definition of a FUTURE WHEEL.
- Know the reasons for using a future wheel.
- Be able to construct a future wheel and point out needs and consequences.

Lesson 22

- Know what a SCENARIO is and be able to describe different types of scenarios.
- Be able to write a scenario to describe possible future events.

Lesson 23

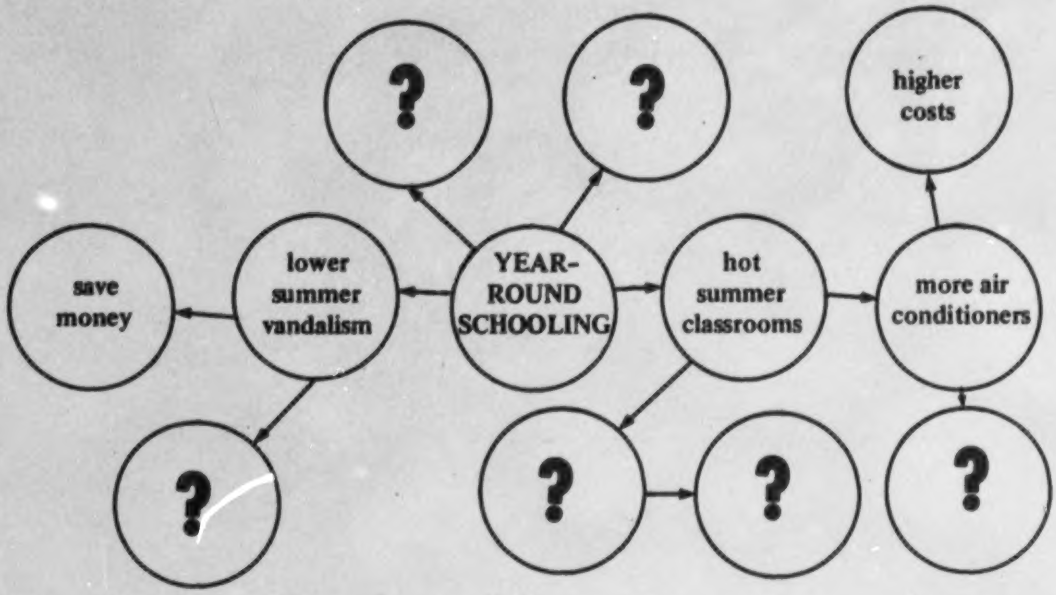
- Be able to use future wheels and scenarios to evaluate some possible future inventions.
- Be able to work well with other students in your group.

FUTURE WHEEL

A "future wheel" is a method of looking for possible consequences and needs that may result from an event or development. The key questions are:

- *What might be the results if this were to be true?*
- *What might be needed if this were to happen?*

To construct a future wheel, draw a circle that shows the change or development you are interested in. For example, what would happen if the school calendar were changed so that students went to school all year instead of just nine months?


?
?
higher costs
save money
lower summer vandalism
YEAR-ROUND SCHOOLING
hot summer classrooms
more air conditioners
?
?
?
?

Can you see that a future wheel might be used to "brainstorm" possible consequences? It is helpful to continue thinking of consequences until you run out of ideas.

Notice that a future wheel can be used to identify needs as well — "hot summer classrooms" led to the identification of the need for "more air conditioners."

DIRECTIONS:

1. Take out a blank sheet of paper from your notebook and label it *FUTURE WHEEL.*
2. Select a possible development from the list below. Each person in your group should select a different development.
3. Draw a circle in the center of your blank sheet. Label the circle with the development you have chosen.
4. Complete a future wheel for that development. List needs and consequences and consequences of consequences.
5. When you have completed your future wheel, label each circle with an "N" for needs or a "C" for consequences.
6. Take turns sharing your future wheel with others in your group. Ask the group to brainstorm additional consequences for your future wheel.

POSSIBLE DEVELOPMENTS

A. **Automobile ban in city centers**– It may be necessary to ban private cars from the centers of towns and cities.

B. **Automobile speed control** – To conserve gasoline and reduce accidents, it may be necessary to prohibit the manufacture of automobiles that can accelerate rapidly and go faster than 55 mph.

C. **Cancer cure** – Medical scientists may find a cure for all or some types of cancer.

D. **Cloning** – We may be able to place a cell from one individual (the donor) in the womb of another individual (the host) causing the development of an identical copy of the donor.

E. **Energy rationing** – It may become necessary to limit the amount of gasoline, fuel oil and electricity that a family may use.

F. **Guaranteed consumer goods** – To conserve energy, manufacturers may be required to guarantee that all major consumer products will work for a given number of years (for example, TV's for 15 years, autos for 20 years, refrigerators for 30 years).

G. **Meat rationing** – It may become necessary to limit the amount of meat that a family can consume.

H. **Parenting license** – In order to make sure that all children get the care and attention they need, it may be necessary to require that couples take a course in parenting before they can legally have children.

I. **Prolonged life** – Advances in the health sciences may increase the average life span to 100 years.

J. **Rapid ground transport** – Using new methods of propulsion (magnetic power, airjets, gravity vacuum systems), it may be possible to travel by train from New York to San Francisco in five hours.

K. **Retirement at age 50** – Population increases combined with advances in automation may mean a drop in the mandatory retirement age.

L. **Sex determination** – We may be able to choose the sex of children in advance.

M. **Weather control** – It may become possible to achieve limited control over the weather in some areas.

N. **Work week of 30 hours** – Advances in work efficiency may mean that the 30-hour work week becomes standard.

SCENARIO

A scenario (pronounced se-nar-ee-o) is a story set in the future. It is based on one or more trends or forecasts and is itself a forecast. A good scenario is rich in detail. It may be imaginative. It is always a story about a possible future. Since there may be more than one possible future developing from a given trend, futurists often write several different scenarios based on one trend. In that case, each scenario describes a possible alternative future.

Some science fiction stories are scenarios. Writers such as Isaac Asimov (physics), Arthur C. Clarke (aeronautics), J. Michael Crichton (medicine), and Chad Oliver (anthropology) write science fiction stories which are scenarios or are based on scenarios.

Futurists and environmentalists write scenarios to describe a possible future to the general public. Well-known scenario writers include Herman Kahn of the Hudson Institute, Rachel Carson, and Paul Ehrlich.

Some scenarios are written in the past tense as if the writer had already experienced life in the future. Some scenarios are personal and others are general. Nearly all scenarios are written to answer the question, "What would happen if...?" (E.g., "What would happen if this trend continued or this invention or development became common?")

Here are passages from two scenarios:

> "On his way into the kitchen Andrew Mann touched the "CAR" button on the electronic communications panel. By the time he had finished breakfast, a rented Electracar, delivered automatically from the town depot, was waiting for him at the door. Andrew slid into the sleek two-seater, inserted his All-Credit Card (which acted as both ignition key and accounting agent), and was on his way."
>
> H. Hellman, in *Transportation and the World of the Future*, 1968.

> "Mattern's home is quite adequate. There are nearly 90 square meters* of floor space. The sleeping platform deflates; the children's cots retract; the furniture can easily be moved to provide play area. The screen and data terminal occupy two-dimensional areas of wall that once had to be taken up by TV sets, bookcases, and other encumbrances. It is a spacious apartment, particularly for a family of six."
>
> R. Silverberg, in "A Happy Day in 2381," 1970.

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*NOTE: Ninety square meters equals about 30' x 36' or three rather small rooms by today's standard.

Scenarios are often written in order to get ideas about what an alternative future world might be like. For example:

> "If we can control the weather, what things might change? Will the world be better or worse? How? How will I be affected?"

There are different kinds of scenarios:

- Looking back on history

  "The year is 2017. Many things have changed since the 20th century. In the 1980's there was a... and then in 1992, America..."

- Chain of events

  "Within five years we will have a... Following that, America will... This will cause... and... which in turn will result in... I will be... by the year..."

- A day in your life

  "The year is 2037. I just got up and am on my way to... My friend, who just got back from... tells me that scientists there just invented..."

Scenarios are not always pleasant. Scenarios often take a trend that has negative consequences and carry it to its conclusion:

> "The end of the ocean came late in the summer of 1979, and it came even more rapidly than the biologists had expected. There had been signs for more than a decade, commencing with the discovery in 1968 that DDT slows down photosynthesis in marine plant life. It was announced in a short paper in the technical journal, *Science,* but to ecologists it smacked of doomsday. They knew that all life in the sea depends on photosynthesis, the chemical process by which green plants bind the sun's energy and make it available to living things. And they knew that DDT and similar chlorinated hydrocarbons had polluted the entire surface of the earth, including the sea."

Paul R. Ehrlich, "Eco-Catastrophe"
in *The Futurists,* A. Toffler (ed.)

DIRECTIONS:

1. **Write the heading *SCENARIO* on a clean piece of notebook paper.**
2. **Select another development from pages 146-147.
Use the following criteria for your choice:**
    a. I believe this will happen by the time I am 30 years old.
    b. I am in favor of this development.
    c. It will affect my life.
3. **Construct a future wheel for this development (take no more than five minutes to complete the future wheel).**
4. **Choose two other developments from pages 146-147 by using the same criteria. List these developments under your future wheel.**
5. **Write a scenario that describes what the world will be like when you are 30 years old. Describe a world in which all three of the developments you chose have come to be. Use your future wheel for ideas.**

Lesson 22

TO: Members of the VISTA PLANNING COUNCIL

DATE: May 17, 1998

SUBJECT: Life in Vista

Now that the plans for the housing units of Vista have been drawn, it's time for you to use your skills and imagination on more difficult problems.

What kind of town do you want to live in? What is most important to you? How might you make living and working in Vista as rewarding and pleasant as possible? How will you achieve "quality of life" without wasting resources? What will your educational system be like? How will you provide for the health of Vista residents?

I hope you take the time to make the best decisions possible about these matters. The rest of the country is watching your experiment very carefully.

Good luck.

Barbara Chan

Barbara Chan
Vice President of the United States
Honorary Chairperson, Project Vista

THE COMMITTEE ON THE ENVIRONMENT

You and the other members of your group make up Vista's Committee on the Environment. You are quite concerned about the amount of natural resources used and wasted by Americans. You would like to see the Vista Planning Council pass some strict conservation laws to reduce waste and to insure a clean environment.

One of your special interests is paper. Over 40 million tons of paper are used in the U.S. each year. Every day, enough newspaper pages are printed to circle the earth 50 times. More than half of the 900 million pounds of solid waste created each day in the U.S. consists of paper and paper products. Because of your concern for the environment and for energy conservation, you would like to see a reduction in Vista's use of paper.

As a member of the Committee on the Environment, you have been asked to develop ideas for the use of a new invention, the TELECOMMUNICATOR. Read the information about the Telecommunicator on the following pages. As you read this information, think about the following questions:

1. Will this invention be good or bad for the environment?
2. What might be the positive and negative consequences?
3. What problems might the invention solve?
4. What problems might the invention create?
5. In what ways might the invention be used?
6. Should my committee approve this invention as proposed or modify it for the good of the Vista community?

THE TELECOMMUNICATOR

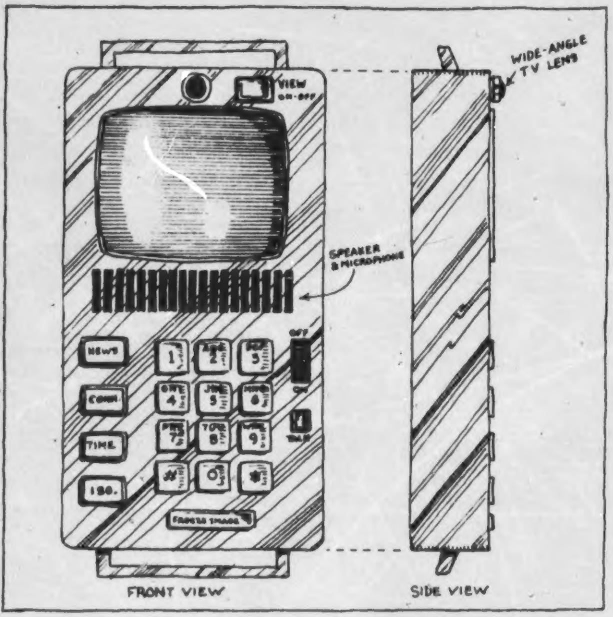
Recent breakthroughs in electronics research have made it possible to supply each resident of Vista with a personal Telecommunicator.

The Telecommunicator is a small device only slightly larger than a wristwatch that will have the following capabilities:

- **Radio receiver** – It will be possible to pick up clear radio signals from as far away as 200 miles

- **Instant directions** – The Telecommunicator can be used to request and receive a great variety of information. Among the "resource packets" that a Telecommunicator could ask for might be city maps, train schedules, restaurant menus, recorded messages as well as all the information now contained in the world's telephone books.

- **Radio transmitter** – It will be possible to use the Telecommunicator as a portable telephone. The wearer will be able to speak to any other person with a Telecommunicator simply by dialing that person's number using the small "touch tone" numbers at the side of the device.



- **Picture phone** – The Telecommunicator will be able to send and receive the image or picture of its wearers. Simply by holding the device in front of your face and pressing a button, your image will be transmitted to the person with whom you are talking. At the same time you will be able to see your caller on the screen in front of you.

- **Miniature portable television** – The Telecommunicator will have a two-inch, TV-like screen on its face which will be able to pick up an unlimited number of channels. A special telescopic attachment will be provided to magnify the image, making it possible to read print.

The Telecommunicator will work without wires or antennae and is powered by a very small battery guaranteed to work for years.

The Telecommunicator will come in various sizes and be available as a bracelet, a detachable belt buckle, perhaps even as an attachment to eyeglasses.

THE COMMITTEE ON WORK

You and the other members of your group make up the Vista Committee on Work. You are quite concerned about improving work conditions, raising wages, creating jobs and making work more interesting and rewarding. You would like to make sure that Vista is a pleasant place to live and work.

You have two special interests. One is job satisfaction. You would like to eliminate work that is dull and repetitive. Machine operators who push buttons all day and assembly line workers who do the same job over and over again are usually more dissatisfied with their jobs than are other workers.

Your second interest is increasing the number of women in the work force. Labor statistics show that despite the fact that there are more women than men in the country, working men outnumber working women by about two to one. Child care is a major reason for this imbalance. You would like to find a way to free women of housework and child care worries so that they could find rewarding jobs.

As a member of the Committee on Work, you have been asked to develop ideas for the use of a new invention, the ROBOT HELPER. Read the information about the Robot Helper on the following pages. As you read this information, think about the following questions:

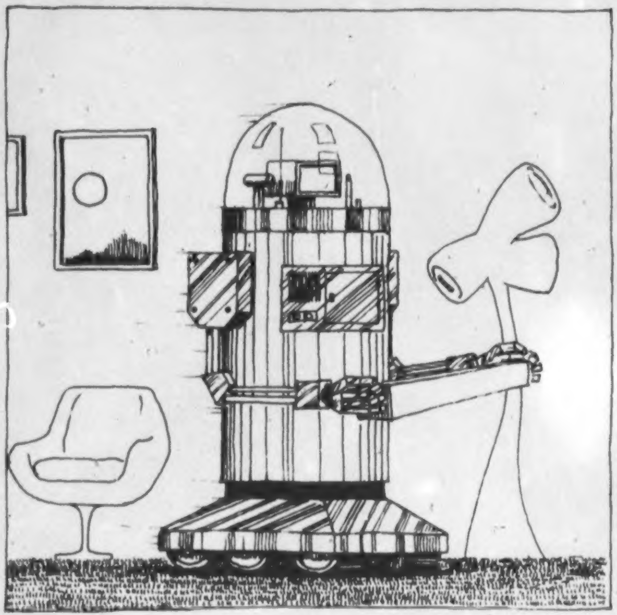
1. Will this invention be good or bad for improving the quality of work?
2. What might be the positive and negative consequences?
3. What problems might this invention solve?
4. What problems might this invention create?
5. In what ways might this invention be used?
6. Should my committee approve this invention as proposed or modify it for the good of the Vista Community?

THE ROBOT HELPER

Recent advances in research on automation have made it possible to produce a workable robot for about the price of a refrigerator. This robot, called the Robot Helper, will be available for each household in Vista.

The Robot Helper stands about five feet tall, weighs 300 pounds, and is capable of lifting twice its own weight. The Helper will come equipped as well as programmed to perform a number of different types of tasks including domestic chores like washing dishes, moving furniture, clearing tables, painting the walls, and answering the phone or door. The Robot Helper is not just a mechanical butler, however. Each Helper will have the following general capabilities:

- **Movement** – The Robot Helper will be programmed to perform hundreds of different movements and operations. The Robot Helper can move at a speed of five mph and can climb stairs, bend down, extend its limbs, and avoid obstacles.



- **Artificial senses** – The Robot Helper will be able to see, hear, touch and smell. It will have a tiny TV camera attached to its carriage that will be able to "look at" and record what it "sees." This pattern recognition device will allow the Robot Helper to recognize objects and "decide" on an appropriate action. For example, it will see that a certain object is china and not silverware and thus needs to be washed in a different way. The Helper also will be equipped with sensors that will identify objects by touch. A range-finder device will enable it to find its way around without running into obstacles.

- **Artificial intelligence** – The Robot Helper will be able to "think" to some degree. It will be able to make decisions, correct itself and solve a large number of simple problems. For instance, the Helper will be able to diagnose malfunctions in appliances or decide how to clean a certain room or how to deal with a new emergency situation, provided it has been programmed with the appropriate information.

Lesson 23

- **Communication** – The Robot Helper will be able to understand thousands of verbal commands. The owner will be able to program the Robot Helper to understand new and perhaps more complex demands that are specific to certain situations. The Helper will be able to speak with a limited vocabulary.

- **Movement copier** – The Robot Helper will have the ability to copy movements. By pressing a record button and demonstrating a series of movements, a user will be able to "teach" the Robot Helper how to perform a new task.

The intelligence and communication abilities of the Robot Helper would be limited, of course, to the computer program that it comes with, and each robot would have to be programmed for a particular environment. But, the Robot Helper could be easily programmed to perform new tasks and could be programmed to learn so that it would continue to get better at what it does.

The Robot Helper would be built to last for 25 years.

THE COMMITTEE ON EDUCATION

You and the other members of your group make up the Vista Committee on Education. You are quite concerned about providing educational opportunities for all citizens. You would like to see Vista adopt policies that would make it possible for more people to get a better education.

One of your special interests is the idea of life-long learning. In this rapidly changing world, old jobs are disappearing and new jobs are being created each day. You believe that it is silly for schooling to end when a person is 21 years of age. The rapid growth of new information means that information will often be out of date soon after it is introduced. You believe that people should have the opportunity to gain knowledge and learn new skills throughout their lives. Life-long learning would make it possible for people to be re-educated and change careers three or four times in a lifetime.

As a member of the Committee on Education, you have been asked to develop ideas on the use of a new invention, the SOCRATES. Read the information about the Socrates on the following pages. As you read this information, think about the following questions:

1. Will this invention be good or bad for the environment?
2. What might be the positive and negative consequences?
3. What problems might the invention solve?
4. What problems might the invention create?
5. In what ways might this invention be used?
6. Should my committee approve this invention as proposed or modify it for the good of the Vista community?

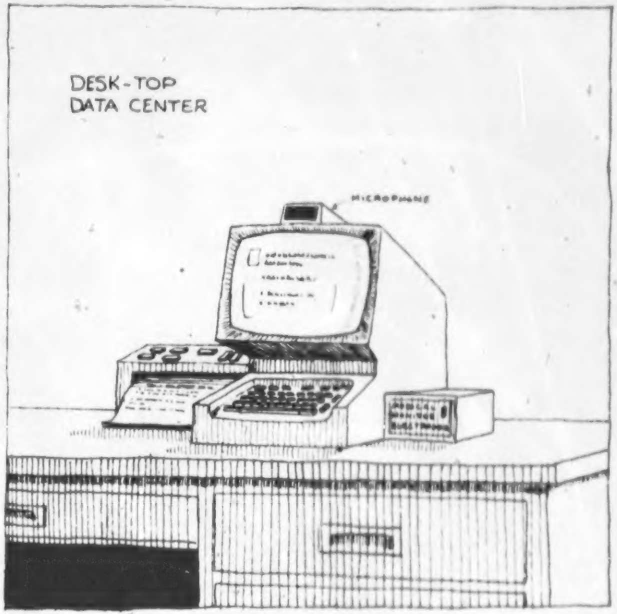
THE SOCRATES

The Socrates, named after the ancient Greek philosopher, is the latest development made available through the activities of computer experts at the Syncom Computer headquarters. The Socrates is a highly sophisticated computer terminal that can be placed in each household in Vista as easily as installing a telephone.

Each Socrates terminal, though no larger than a television set, will be equipped with a screen to display information, a keyboard to allow the Vista resident to type information or questions, a printer which would provide the resident with a paper copy of anything displayed on the screen, and a two-way communication system which would allow the Vista resident to speak to the computer.

In addition, the Socrates would have the following capabilities:

- **Information retriever** – The Socrates would be linked directly to the Syncom computer, the largest computer facility in the world. The Socrates would provide an "instant library." Anything ever recorded (books, magazines, reports, speeches, movies) could be instantly flashed on the screen at the user's request.



- **Instant librarian** – In the event that the user has a question but does not know where to find the answer, the Socrates will usually "know" where the answer can be found and will retrieve the appropriate information source and flash it on the screen.

- **News service** – The Socrates will be able to keep residents up to date on events and developments around the world. Since the Socrates can convert print into speech and speaks five languages, it will be able to translate the news for all residents, including the deaf and blind.

- **Home medic** – Special attachments will allow the Socrates to diagnose health problems and suggest treatment. The Socrates would not only be able to perform certain physical tests but would be able to ask questions and consult its data bank before reaching conclusions.

- **Problem solver** – The Socrates is linked to the Syncom computer, which in many ways is more intelligent than humans. Socrates' two-way communication capacity will allow a person to interact with Socrates to solve complex problems. The Socrates will be able to counsel people about where to go on a vacation, whether to quit a job, how to reduce the heating bill, how to stop smoking, etc.

- **Consumer helper** – The Socrates will be able to handle all financial arrangements for Vista residents. And because of its information retrieval capacity, a Vista resident will be able to shop for anything without leaving the house. The Socrates can show pictures of different products, compare prices, take orders, withdraw the money for the purchase and place the order with the store or company.

- **Patient teacher** – The Socrates will be able to teach thousands of courses on a great variety of topics. Because it will be possible to speak directly to Socrates and because Socrates can ask as well as answer questions, the Socrates can function as a personal tutor. Students will be able to proceed at their own rates of speed. Socrates will be able to give and grade assignments, and the keyboard will allow students to respond to learning material and to take written tests.

THE COMMITTEE ON HEALTH AND WELFARE

You and the other members of your group are members of the Vista Committee on Health and Welfare. You are quite concerned about improving medical practices and seeing to it that more people live longer, healthier lives. You would like to see the Vista Planning Council put more money into making people happier and healthier.

One of your special interests is pain. In your study of the nation's health, you have found that a large number of people suffer unnecessary pain. Pain is responsible for 18 million visits to doctors' offices each year. More than $900 million is spent each year in attempts to control pain. Because of your concern with relieving pain, you would like to see the Vista medical community take special steps to make sure that suffering is not part of life in Vista.

As a member of the Committee on Health and Welfare, you have been asked to develop ideas for the use of a new invention, the BIO-REGULATOR. Read the information about the Bio-Regulator on the following pages. As you read this information, think about the following questions:

1. Will this invention be good or bad for the health and welfare of Vista?
2. What might be the positive and negative consequences?
3. What problems might the invention solve?
4. What problems might the invention create?
5. In what ways might this invention be used?
6. Should my committee approve this invention as proposed or modify it for the good of the Vista community?

THE BIO-REGULATOR

Recent advances in medical knowledge, combined with breakthroughs in electronics, make it possible to offer the amazing new Bio-Regulator to all adult residents of Vista.

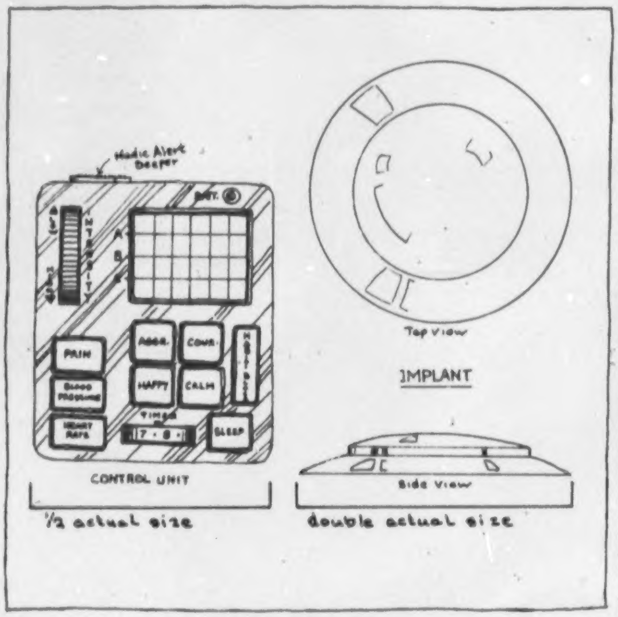
The Bio-Regulator consists of a tiny radio receiver/transmitter that is implanted underneath the scalp and a pocket-size, monitor-control unit. The Bio-Regulator will be able to monitor electrical impulses from the brain as well as stimulate different parts of the brain. This will allow the wearer to do the following:

- **Control pain and tension** – The Bio-Regulator will be able to eliminate most forms of pain. A button on the control unit will allow the wearer to block pain impulses, relax muscles and ease tension.

- **Control abnormal body responses** – The Bio-Regulator can be used to control the pulse rate and electrical activity in the brain. Stroke patients can use the Bio-Regulator to monitor and avoid strokes; epilepsy patients can control their seizures. Parents of hyperactive children can use the Bio-Regulator to control their children's behavior.

- **Control moods** – The Bio-Regulator will allow a wearer to select a mood by setting the regulator and activating the appropriate brain center. An individual could select the mood that works best for him or her at a particular moment — aggressiveness, courage, happiness, quietness. Wearers could put themselves to sleep or wake themselves up by selecting the appropriate frequency and setting a timer.

- **Control habits** – The Bio-Regulator will allow addicts and people with strong habits to control their desires. People will be able to stop smoking, avoid the desire for drugs or alcohol, or even resist the temptation to be destructive or commit a crime.



In addition to the self-control capability, the Bio-Regulator can be programmed to work automatically like a Heart Pacemaker and it can be worked by remote control. The remote control capability would allow a doctor to relieve the pain experienced by a bedridden patient miles away.

DIRECTIONS FOR COMMITTEE MEMBERS

Getting Started: Read the two pages that describe your committee's concerns and the invention you are to evaluate.

Round One: In Round One you are responsible for identifying as many uses and applications for your invention as you can. In order to get the maximum amount of points, complete the following tasks:

1. Use **brainstorming** and other **idea techniques** to make a list of as many **ways that your invention might be used** as you can think of. Think of **new** ideas.
2. Put together a presentation to the Senate. This first presentation should focus on:
   a. the many **uses** of your invention
   b. the ways your invention will **benefit** the residents of Vista (especially Health, Education, Work and the Environment).

   Special instructions for the liaison agents: Spend time during Round One meeting with the liaison agents from other groups. Follow the directions on page H-31 to construct a cross-impact matrix showing **possible ideas for combining your invention with the other three inventions** on the matrix. Take your ideas back to the reporter for your group who will present them to the Senate.
3. Present your ideas to the Senate. You will receive points for the **number** and **quality** of your ideas.

Round Two: In Round Two you are responsible for identifying possible consequences for your invention. In order to get the maximum number of points, complete the following tasks:

1. Construct **future wheels** and write **scenarios** to make a list of as many possible **positive consequences** as you can think of for your invention.
2. Use **future wheels** and **scenarios** to identify possible **negative consequences.** For each negative consequence you identify, try to think of at least one way you could prevent this consequence from becoming serious.

   Special instructions for the liaison agents: Spend time meeting with the liaison agents from other groups. Follow the directions on page H-32 to construct a cross-impact matrix showing possible cross-impacts (consequences) of the four inventions. Take your ideas back to the reporter for your group who will present them to the Senate.
3. Present your possible positive and negative consequences to the Senate. You will receive points according to how well you identify possible **benefits** for Vista citizens and for how well you identify possible **costs or disadvantages** for citizens.

Round Three: In Round Three you are responsible for identifying the most serious problem or problems that might occur as a result of your invention and for presenting one or more solutions to the Senate. In order to get the most points, complete the following tasks:

1. Brainstorm possible problems.
2. Select what you think is the most serious problem (or problems).
3. Define the problem, think of ideas, judge your ideas, select the best idea and plan how you would put the idea into practice.
4. Present your idea(s) to the Senate. You will receive points according to:
    a. whether you identified the most serious problems;
    b. how well you defined your problem(s);
    c. the quality of your solution idea.

DIRECTIONS FOR THE SENATE:

Getting Started: Read the description of all four committees and all four inventions.

Your job: Each of the four committees will be making three presentations to you. Your job is to evaluate these presentations and award points to each committee for each presentation. Each committee will be trying to convince you that their invention will benefit the community more than other inventions. Each committee will be trying to convince you to award them the largest share of Vista's resources (money) in order to expand the use of their invention.

Your job is to make sure that Vista's resources are spent for the good of all Vista residents and to make sure that the inventions serve to improve the quality of life in Vista.

Round One: In Round One, the four committees will be presenting their ideas for how their inventions might be used. You are responsible for awarding 300 total points to the four groups. You may give each group 75 points, or you may give a group as few as 50 or as many as 150 points. It is completely up to you. In order to be as fair as possible, complete the following tasks:

1. Make up a criteria chart to be used to award points to the committees. You will probably want to consider how many ideas were presented, how good the ideas were and how these ideas would benefit the people of Vista. Work with your teacher to develop a set of criteria.
2. Listen carefully to the presentations. Take notes. Do not award points for the presentations until you have heard them all.
3. Discuss the presentations with members of the Senate. Fill out your criteria chart. Award points according to the chart.
4. Tell your teacher when you are ready to announce the awards for Round One.

Round Two: For Round Two, the four committees will be presenting their views of the positive and negative consequences that might result from the inventions. You will be responsible for awarding 300 total points to the four groups. Again you may give as few as 50 or as many as 150 points to any group. In order to be as fair and as informed as possible, complete the following tasks:

1. Complete a future wheel for each invention. Identify possible positive and negative consequences. (Dividing this task among your members will make the job easier.)
2. Construct a cross-impact matrix. Fill out the diagram shown on page H-32. Try to identify as many of the cross-impacts that might result from the four inventions as possible.

3. Make up another criteria chart to be used to award points to the committees. You will probably want to reward a committee for the number and kind of consequences they thought of (positive and negative) and for taking the best interests of all residents into account. Ask your teacher for assistance.
4. Listen carefully to the presentations. Take notes.
5. Discuss and judge the presentations with your group.
6. Award points.

Round Three: For Round Three the four committees will be presenting their ideas for solving some of the possible problems identified in Round Two. You will be responsible for awarding a total of 400 total points to the four groups. Again, you may give as few as 50 and as many as 150 points to any group. In order to be as fair as possible, complete the following tasks:

1. Brainstorm possible problems that might result from the inventions (from each invention alone or from combinations of inventions).
2. Construct a criteria chart for judging the ideas presented by the committees. Judge the presentation on the importance of the problems chosen and the quality of solution ideas. Remember that you are representing **all** Vista residents.
3. Listen to the presentations carefully.
4. Discuss and judge the presentations with members of the Senate.
5. Tally the scores from all three rounds.
6. Announce your awards and the final winner. Give reasons for your final rating.

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